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Energy Research Abstracts

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Office of Scientific and Technical Information
UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Coverage

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports and patent applications originated by the U.S. Department of Energy, its laboratories, energy centers, and contractors, as well as theses and conference papers and proceedings issued by these organizations in report form. Audiovisual materials, computer media (magnetic tapes, diskettes, etc.), and engineering drawings are included in this definition. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations, *provided* that the full text of the document has been received by OSTI. Foreign report information is obtained through the International Energy Agency's 18-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. The purpose of this publication is to announce documents produced or obtained by DOE that are not so readily available as journal articles, books, or patents.

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The scope of *ERA* encompasses DOE's research, development, demonstration, and technology programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for online searching as records within the Energy Science and Technology Database (EDB). The current-year records are available on the Integrated Technical Information System (ITIS).

Availability

DOE and DOE contractors can obtain *ERA* (regular issues and annual indexes) by using VISA, MasterCard, or OSTI deposit accounts. Contact the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831, Attention: Information Services. For further information, call (615)576-8401. *ERA* is also available at authorized GPO Depository Libraries. (List is provided on the inside back cover.)

ERA (regular issues and annual indexes) is available to the public on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Managing Editor, Leota S. Kane
Technical Editor, Barry C. Steele

Information Sources

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The **Energy Technology Data Exchange (ETDE)** was established by the International Energy Agency to promote cooperation among members in conducting appropriate energy-related research and development programs through the development of a formal central information sharing system. In accomplishing the objectives of the ETDE, members select, abstract, and index relevant research information published in their countries in accordance with Exchange standards. OSTI serves as the central receiving and processing center for this information, which it then disseminates to national centers in the participating countries. The following countries are currently members of the ETDE:

Australia	Norway
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Canada	Republic of Korea
Denmark	Spain
Finland	Sweden
France	Switzerland
Germany	The Netherlands
Italy	United Kingdom
Japan	United States

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The principal data elements included in these citations are:

1. **Abstract number** within volume.
2. **Report number** identification for report-type literature.
3. **Title and subtitle** (non-English title may appear in parentheses, if applicable).
4. **Author(s).** First 10 names in the data record are printed, then "et al." is listed.
5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Date of publication.** If not known, a processing date is in brackets.
9. **Number of pages** or page range. Prices are based on total pages unless special pricing applies.
10. **Language** of document if non-English.
11. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
12. **Sponsoring organization.**
13. **Contract or grant number.**
14. **Secondary identifying number;** may be a conference number.
15. **Conference title, location, and date,** if applicable.
16. **Order number.** The "DE" order number may be used for ordering from NTIS or OSTI, as appropriate. The "TI" prefix is valid only at OSTI.
17. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
18. **Drop note** or explanatory statement.
19. **Abstract.**
20. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. **Wisconsin Univ., Madison (USA). Dept. of Physics.** [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246. **Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.**

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

54 (DOE/ER/60888-1-Vol.1, pp. 115-117) **Investigation of air pollution in house due to use of various fuels.** Luo, Dayu (Chengdu Sanitation (China)). Canada Mortgage and Housing Corp., Ottawa, ON (Canada). 1990. (CONF-900724-Vol.1: Indoor Air '90: 5th international conference on indoor air quality and climate, Toronto (Canada), 29 Jul - 3 aug 1990). In Indoor air '90: The fifth international conference on indoor air quality and climate. Volume 1: Final report. 786p. Order Number DE90017786. Source: NTIS.

Air pollution in houses caused by combustion of coal is more serious than that by combustion of natural gas and methane (primarily by SO_2 and NO_2). The gas concentration after cooking is higher than that before cooking, and it is higher in kitchen than in bedroom and outdoor. There were mutations in the extract from TSP in $30m^2$ air in the bedroom, kitchen and outdoor, where coal and natural gas were used. The supernatant saliva activity of children whose family uses coal is significantly lower than that of pumping streams.

How To Order from the Availability Sources

TO OBTAIN A REPORT

Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 2 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) OSTI prices are based on total pages unless special pricing applies. The public should order from NTIS or from one of the other agencies listed in the citation. NTIS price codes may continue to appear in some records. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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Government Printing Office
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GPO Dep. Available for inspection or interlibrary loan at Government Printing Office regional depository libraries.

INIS *Available only in microfiche.*
INIS Clearinghouse
International Atomic Energy Agency
P.O. Box 100, A-1400
Vienna, Austria

NTIS U.S. Department of Commerce
Technology Administration
National Technical Information Service
Springfield, VA 22161

OSTI U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831
Fax: (615) 576-2865
e-mail: reports @adonis.osti.gov

ESTSC Energy Science and Technology Software Center
P.O. Box 1020
Oak Ridge, TN 37831-1020

CASI Attention: Document Order
NASA Center for AeroSpace Information
800 Elkridge Landing Road
Linthicum Heights, MD 21090-2934

How To Use the Indexes

Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 15:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 15:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 15:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 15:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
15:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**

Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438–T1 15:18494 NTIS, OSTI E 1.99: DE89007246 MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the database records.* The following list includes all of the 38 first-level and the 313 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

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*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in ETDE/PUB--1-R2, *International Energy: Subject Categories and Scope*.

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Energy Research Abstracts

01 COAL, LIGNITE, AND PEAT

4869 (NEDO-GET–9218) **Feasibility study of coal utilization system in harmony with the environment. Present status of and tasks necessary for the coal utilization technology in China.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 253p. (In Japanese). Order Number DE95730263. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

Problems were extracted through investigation on the coal utilization system focused on the environmental measures for the coal utilization in China. In China, the coal accounts for 74% of all the commercial energy consumption. The coal and its products do for 75%, 65% and 85% in the industrial fuel and power-related division, processed material-related division, and urban and livelihood-related division, respectively. Most of the coal is used for the direct burning in the three main fields, i.e., industrial boilers and furnaces, power generation, and livelihood. Therefore, they are the main objectives toward which measures are to be taken for the rational, effective and clean utilization of coal. In this manner, problems and future trends were set forth for the coal utilization in China. It was then concluded that the following matters are necessary: coal washery to increase the coal supply, briquetting, utilization of fluidized bed boilers and coal-water mixture, modification of boilers and furnaces to heighten the efficiency of energy utilization, promoted installation of dust collectors and flue gas desulfurizers, clean and effective use through the thermal supply and city gasification. 93 figs., 78 tabs.

0103 Preparation

Refer also to citation(s) 4962, 6091

4870 (CONF-940780–Vol.1, pp. 1-8) **Solvent refining of fossil resin flotation concentrate from western coals.** Miller, J.D. (Univ. of Utah, Salt Lake City, UT (United States)); Jensen, G.F.; Yu, Q.; Li, L.L.; Yang, Z.Y.; Ye, Y. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Macroscopic fossil resin from the western coal fields is a unique resource in the United States. Such resinous coals are found in the states of Arizona, Colorado, New Mexico, Utah, Washington, Wyoming, etc. Among these, the Wasatch Plateau coal field in central Utah has a particularly high content of macroscopic coal resin. Many seams in this coal field have been reported to contain as much as 5% resin by weight. This fossil resin varies in color from lemon yellow to dark brown and has a market value of $0.40-0.70/lb, depending on its color and softening point. It is used as an additive in the adhesives, rubber, varnish, paints, coatings, and thermoplastics industries, and particularly in the ink industry. Resin concentrates thus produced can be refined by solvent extraction with the resin product finally recovered by evaporation of the solvent. Production, nevertheless, has been on a very small scale and the technologies used have limited the development of a viable fossil resin industry. Because of the lack of technology for the efficient recovery of resins from coal this valuable resource has been wasted, being burned together with coal for electric power generation. It is estimated that the fossil resin from the Wasatch Plateau coal field burned each year for electric power generation has a value of $100 million - equivalent to the value of the coal itself. In view of this situation, the University of Utah and Advanced Processing Technologies, Inc., with support from the US DOE, have initiated a research program on the continuous refining of these fossil resin flotation concentrates. The program includes batch extraction kinetics, product characterization, circuit design and construction, and continuous refining of the resin concentrate. It is expected that the successful completion of the project will provide much-needed proof-of-concept data for fossil resin refining and ultimately the establishment of a fossil resin industry.

4871 (CONF-940780–Vol.1, pp. 9-16) **Recovery and utilization of fine clean coal in a thermal dryer system.** Breault, R.W. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Two specific problems exist at a large number of coal preparation plants in the United States that use thermal dryers for producing product coal, cyclones for first-stage recovery of coal fines, and second-stage wet scrubbers to remove coal carry-over from the dryer exhaust gas. The first problem involves a need for eliminating the common practice of sacrificing clean ultra-fine coal captured in the scrubbers. The second problem involves a need for mitigating over-dry fine coal dusting from in the dryer product. The second problem, controlling fine coal dusting, has been met by applying a solution of surfactants and process water to the over-dry coal fraction, de-dusting the product coal. To date, the problems associated with the recovery and use of fine clean coal from dryer scrubber effluent have not been solved. The program, reported in this paper, demonstrates a simple process improvement, involving use of a belt press, that will simultaneously solve both the de-dusting and the dryer scrubber effluent recovery issues. This program proposes to use a combination of a clean coal thickener with a squeeze belt press to recover the ultra-fine coal in dryer scrubber effluent before it is mixed in with the balance-of-plant tailings. As an additional essential part of this program, we propose to demonstrate that the coal-water mixture (CWM) produced from the scrubber sludge of a thermal dryer can be used as a dust suppressant. The net effect of these two coal circuit changes will be to integrate the thickener underflow into the thermal dryer circuit. This will essentially close the loop and permit maximum efficiency from the system, by recycling a former waste stream (sludge) as an effective dust suppressant.

4872 (CONF-940780–Vol.1, pp. 17-24) **Evaluation of hyperbaric filtration for fine coal dewatering.** Parekh, B.K. (Univ. of Kentucky, Lexington, KY (United States)); Groppo, J.G.; Sung, D.J.; Rawl, P. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

In this university/industry joint project, application of hyperbaric filtration is being evaluated at the laboratory scale for dewatering fine coal cleaned by froth flotation. The dewatering tests on three different clean coals were conducted to identify optimum dewatering conditions with respect to cake thickness, filtration time, percent solids, pH, viscosity and chemical reagents additions.

4873 (CONF-940780–Vol.1, pp. 25-34) **Reconstitution of beneficiated coal using the biobinder process.** Kelly, J. (Altex Technologies Corp., Santa Clara, CA (United States)); Woodworth, R.; Namazian, M.; Miller, G. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Coal fines can be beneficiated by froth flotation to produce a clean fuel. However, the resulting product consists of a wet cake material that is difficult to handle, store and transport. If the material dries, it will become dusty and can be an explosion hazard. If it remains wet, it can be subject to freezing. As an alternative to this form, the cake could be processed into pellets, that have much improved handling, storage and transport characteristics. Patents relating to the pelletizing of coal fines can be found as far back as the 1920's. In these early efforts, the purpose of pelletizing the coal was to reclaim waste coal fines produced as part of the coal washing process. More recently, it has been of interest to develop an inexpensive coal based fuel that has lower sulfur emissions and ash levels. This beneficiated fuel could be used in a range of combustion equipment to meet evolving regulatory constraints. Further, if the coal was sufficiently cleaned, it could even be used as a substitute for oil or gas in existing combustors.

4874 (CONF-940780–Vol.1, pp. 47-54) **Bench scale testing of micronized magnetite beneficiation.** Anast, K. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-93PC92206. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Amax Research & Development Inc. (Amax R&D) was awarded a cost-shared contract to design, fabricate, install and operate a 500 lb/hour fine coal cleaning circuit. This project is one of the three awarded under the "High Efficiency Separation" subprogram to be conducted at PETC's CPPRF. The project, "Bench Scale Testing of Micronized Magnetite Beneficiation", No. DE-AC22-93PC92206, addresses the cleaning efficiency program area. Similar processes based on this concept have been successfully researched at PETC and elsewhere but have not been studied in a continuous bench-scale unit. The project is aimed at development of a process that, by using an ultra fine magnetite suspension, would expand the application of dense medium separation technology to include processing of fine, -28 mesh coals. These coal fines, produced during coal mining and crushing, are separated in the conventional coal preparation plant and generally impounded in a tailings pond. Development of an economic process for processing these fines into marketable product will expand the utilization of coal for power production in an environmentally acceptable and economically viable way. The proposed circuit will utilize ultrafine magnetite and a heavy media cyclone to impart a gravity separation on fine coal and use a variety of magnetic recovery devices. The proposed circuit is composed of three unit operations which can be evaluated separately and then combined in an integrated fashion. The Test Plan will focus on magnetite recovery, as this portion of the process is critical to economic viability and has not been adequately evaluated in the laboratory. Specifically, fine magnetite loss and magnetite contamination will be closely examined. High efficiency screens, conventional drum magnets, rare earth, and high gradient magnets will be evaluated separately and together in the magnetite recovery circuit.

4875 (CONF-940780–Vol.1, pp. 59-66) **Engineering development of advanced physical fine coal cleaning for premium fuel applications.** Mahesh, C. (Amax R&D Center, Golden, CO (United States)); Smit, F.J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Under this cost-shared contract, an Amax-led team has been working since fall 1992 on engineering development of advanced column flotation and selective agglomeration processes for cleaning of fine coal. Basic project details were presented at the annual contractors meeting last year. The first public presentation on this major coal preparation R&D program was made at the 19th International Technical Conference on Coal Utilization and Fuel Systems. This paper discusses the project accomplishments made since the last annual contractors meeting.

4876 (CONF-940780–Vol.1, pp. 67-74) **Update of the LICADO coal cleaning process.** Chiang, S.H. (Univ. of Pittsburgh, PA (United States)); Klinzing, G.E.; He, D.X.; Feng, Y.R.; Yu, S.N.; Jenkins, K.; Diffendal, G. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

A novel method for fine coal cleaning, the LICADO process, is being investigated in semicontinuous and continuous test equipment. Coals tested include Upper Freeport, Pittsburgh No. 8 and Illinois No. 6 coals. A statistical study of the effects of operating parameters on the process performance with the addition of the surface modification agent was conducted in the multistage semicontinuous Research Development Unit. The Continuous Research Unit has been successfully operated at high throughput (up to 20 lb/hr) when a small amount of the surface modification agent, No. 6 fuel oil, was added to the feed slurry for Pittsburgh No. 8 coal. Excellent results in terms of Btu recovery, ash reduction, and pyritic sulfur reduction have been achieved at a feed rate up to 14 lb/hr (the design capacity of the Continuous Research Unit is 10 lb/hr).

4877 (CONF-940780–Vol.1, pp. 75-83) **Evaluation, engineering and development of advanced cyclone processes.** Durney, T.E. (Coal Technology Corp., Bristol, VA (United States)); Cook, C.A.; Suardini, P.J.; Lauria, M.J.; Ferris, D.D.; Devernoe, A.L. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-90PC90177. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

This research and development project is one of three seeking to develop advanced, cost-effective, coal cleaning processes to help industry comply with 1990 Clean Air Act Regulations. The specific goal for this project is to develop a cycloning technology that will beneficiate coal to a level approaching 85% pyritic sulfur rejection while retaining 85% of the parent coal's heating value. A clean coal ash content of less than 6% and a moisture content, for both clean coal and reject, of less than 30% are targeted. The process under development is a physical, gravimetric-based cleaning system that removes ash bearing mineral matter and pyritic sulfur. Since a large portion of the Nation's coal reserves contain significant amounts of pyrite, physical beneficiation is viewed as a potential near-term, cost-effective means of producing an environmentally acceptable fuel.

4878 (CONF-940780–Vol.1, pp. 85-92) **Engineering development of advanced physical fine coal cleaning technologies - froth flotation.** Ferris, D.D.; Bencho, J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-88PC88881. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

ICF Kaiser Engineers (ICF KE) was contracted by United States Department of Energy, Pittsburgh Energy Technology Center, to perform a project entitled "Engineering Development of Advanced Physical Fine Coal Cleaning Technologies - Advanced Froth Flotation". The objective of the project is to develop advanced froth flotation coal beneficiation technology to achieve at least 85% inorganic pyritic sulfur rejection while simultaneously maintaining at least 85% Btu recovery. A two ton per hour Proof-of-Concept (POC) test unit was designed and operated to demonstrate that the removal of inorganic sulfur by physical cleaning prior to combustion as an economical means of controlling acid rain emissions. The contract is comprised of seventeen tasks. The first eleven tasks were completed and reported previously. During this report

period, Task 12, Task 13, and Task 17 were completed. The results of these tasks are summarized in this report.

4879 (CONF-940780–Vol.1, pp. 93-100) **New flotation schemes for enhanced pyrite rejection.** Lu, M.X. (Virginia Polytechnic Institute and State Univ., Blacksburg, VA (United States)); Tao, D.P.; Richardson, P.E.; Luttrell, G.H.; Adel, G.T.; Yoon, R.H. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-92PC92246. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

There are two major reasons for incomplete rejection of pyrite from coal. One is the superficial oxidation of pyrite as an inadvertent corrosion-type process, which results in surface hydrophobicity and, hence, self-induced flotation; the other is incomplete liberation, which causes a large fraction of the pyrite to remain locked with the coal as middlings that show considerable floatability. Two complementary concepts have been developed to address these problems. They are referred to as Electrochemically-Enhanced Sulfur Rejection (EESR) and Polymer-Enhanced Sulfur Rejection (PESR) processes. In the EESR process, electrochemical techniques are used to prevent the formation of hydrophobic oxidation products. Active metals and alloys are used as sacrificial anodes to cathodically-protect pyrite from oxidation. Active metals and alloys are used as sacrificial anodes to cathodically-protect pyrite from oxidation and, hence, improve pyrite depression. The PESR process uses hydrophilic polymers to depress coal-pyrite middlings. Four water-soluble polymers have been studied in microflotation tests.

4880 (CONF-940780–Vol.1, pp. 101-108) **Durability of various raw and dried low-rank coals.** Anderson, C.M. (Univ. of North Dakota, Grand Forks, ND (United States)); Musich, M.A.; Dewall, R.A.; Richter, J.J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Low-sulfur subbituminous coals have high moisture content and, consequently, low heating value, leading to boiler derating in U.S. midwestern and eastern utilities as well as switching and/or blending coals to achieve SO_2 compliance. In their drive to develop cost-effective coal-drying processes, coal developers have focused on heat content of the products and neglected the critical stability issues of friability and dusting, moisture reabsorption, and spontaneous heating. The Energy & Environmental Research Center (EERC), in an effort to establish new standards for dried products, has used various known methods as well as developed new methods to evaluate the propensity of lump western coals, raw and dried, to produce dust and absorb water. Three drying methods, air, hot water, and saturated steam-were used to generate low-moisture upgraded products. New indices for dust generation and friability were determined to assess the effects of moisture removal and upgrading methodology on coal stability. Analysis of the dried coals using various strength tests indicated that the reduction in moisture made the lump coal unstable, yielding substantially higher dust and friability indices relative to those of the raw coals.

4881 (CONF-940780–Vol.1, pp. 111-116) **Electrostatic beneficiation of coal.** Mazumder, M.K. (Univ. of Arkansas, Little Rock, AR (United States)); Tennal, K.B.; Lindquist, D. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Dry physical beneficiation of coal has many advantages over wet cleaning methods and post combustion flue gas cleanup processes. The dry beneficiation process is economically competitive and environmentally safe and has the potential of making vast amounts of US coal reserves available for energy generation. While the potential of the electrostatic beneficiation has been studied for many years in laboratories and in pilot plants, a successful full scale electrostatic coal cleaning plant has not been commercially realized yet. In this paper we review some of the technical problems that are encountered in this method and suggest possible solutions that may lead toward its full utilization in cleaning coal.

4882 (CONF-940780–Vol.1, pp. 117-124) **Non-intrusive measurement of particle charge: Electrostatic dry coal cleaning.** Ban, Heng (Center for Applied Energy Research, Lexington, KY (United States)); Schaefer, J.L.; Stencel, J.M. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract FG22-91PC91290. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Fundamental information on triboelectrification and electrostatic separation of coal and representative mineral matter was obtained. This bench-scale work quantified the charge and charge distribution imparted on coals, silica, alumina, pyrite and other particulate mixtures as a function of their size and velocity within Cu loops and mixer tribochargers. The charge was also measured for these samples at temperatures between 25-140°C and relative humidity between 0-70%.

4883 (CONF-940780–Vol.1, pp. 125-132) **Development of the tribo-electrostatic fine coal separator.** Gerstler, W.D. (Oak Ridge Associated Universities, TN (United States)); Finseth, D.H. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Tribo-electrostatic coal cleaning is a physical method for removing impurities from fine dry coal. The process utilizes the difference in electrical charging characteristics between the clean burning organic material and the mineral matter. Because the mineral matter contains many harmful impurities found in run-of-mine coal, removing it from the organic material can significantly reduce emissions. The goal of this study is to develop a continuous process which cleans dry coal powder, thereby eliminating the need for the energy intensive dewatering step in classical wet separation. The study is simultaneously approaching the problem from the fundamental and practical perspectives. Physical coal beneficiation requires liberation of organic material from mineral matter. Past work indicates that grinding the coal to minus 200 Mesh (below 75 μm) results in effective liberation for tribo-electrostatic separation. There are three basic elements required for an electrostatic dry powder separating system: a particle charger, a separator, and a means to collect the separated material.

4884 (CONF-940780–Vol.2, pp. 679-685) **Compliance advisor: A software tool for fuel switching/blending to meet SO_2 regulations at coal-fired power plants.** Kang, S.G. (PSI Technology Co., Andover, MA (United States)); Goudreau, J.J.; Senior, C.L. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Because of the stringent sulfur dioxide emissions regulations imposed by the Clean Air Act Amendments, a considerable number of utilities are switching to or blending with low-sulfur coals such as Powder River Basin subbituminous coals. Switching to or blending with "non-design" coals, however, can cause many boiler operational problems such as slagging, fouling and failure of particulate collection systems. Guidelines are needed for utilities to select and blend coals which meet SO_2 regulations while minimizing operational problems. The project is designed to develop a user-friendly software environment for utility and coal companies which provides

users with blending strategies that meet sulfur dioxide emissions regulations while saving fuels costs and minimizing operation costs. The idea behind the software environment is that prediction of performance of a coal in a given boiler is possible by carefully studying interaction among coal constituents during and after combustion. The software is being built on existing software packages for the prediction of slagging (Slagging Advisor of PSI Technology) and electrostatic precipitator performance (ADAPCESP of ADA Technologies). The software is also being verified through laboratory-scale and full-scale testing.

4885 (DOE/PC/91164–T10) **Development of the selective hydrophobic coagulation process. Tenth quarterly technical progress report, January 1, 1994–March 31, 1994.** Yoon, R.H.; Luttrell, G.H. Virginia Polytechnic Inst., Blacksburg, VA (United States). [1994]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91164. Order Number DE94017134. Source: OSTI; NTIS; GPO Dep.

A novel technique for selectively coagulating and separating coal from dispersed mineral matter has been developed at Virginia Tech. The process, known as Selective Hydrophobic Coagulation (SHC), has been studied since 1986. The SHC process differs from oil agglomeration, shear flocculation, polymer flocculation, and electrolytic coagulation processes in that it does not require reagents or additives to induce the formation of coagula. Often, simple pH control is all that is required to (1) induced the coagulation of coal particles, and (2) effectively disperse particles of mineral matter. When the coal is superficially oxidized, a small dosage of reagents may be used to promote coagulation. During the past quarter, calculations were carried out under Subtask 2.3 (Predicting Optimum Conditions Using the Extended DLVO Equation) to explain the selectivity window that occurs between pH 7–9 in the SHC process. These calculations suggest that particle interactions involving the edge surfaces of clay are the most important, while interactions involving silica and face surfaces of clay are not as important. Experiments were also continued under Subtask 3.3 (Advanced Separation Methods) to investigate the performance of a centrifuge for separating hydrophobic coagula from dispersed mineral matter. These tests show that coagula recovery increases with centrifugal field strength and decreases with solids content and feed flow rate. Work is now in progress to evaluate the performance of a vacuum filter for coagula recovery.

4886 (DOE/PC/92521–T179) **Characterization of coal particles using rule base on-line image analysis. Final technical report, September 1, 1993–August 31, 1994.** Yen, S.C.M. (Southern Illinois Univ., Carbondale, IL (United States)); Chu, T.C. Illinois Dept. of Energy and Natural Resources, Springfield, IL (United States). [1994]. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-92PC92521. Order Number DE95003555. Source: OSTI; NTIS; GPO Dep.

The degree of pyrite liberation is a key to determine whether a batch of ground coal obtained through a grinding process is acceptable. In this regard, a synthesis so-called on-line image analysis system to be used as a part of a coal cleaning process has been developed. This system is designed to replace the traditional method in the assessment of pyrite liberation of ultrafine coal. The online image analysis system consists of two parts: an automated image analysis computer program and an automated sample handling system which is an assembly of an optical microscope, a video camera, a X-Y table, an autofocus unit, and a personal computer. The automated image analysis computer program performs the analysis of coal particles without any intervention of a human operator. The image analysis computer program is a rule base decision-making algorithm and is the creation of an extensive study of image characteristics of coal particles such as shade of gray, particle size etc. In general, the image analysis computer program developed in this project can identify different particles in a coal image as good as a human operator does. On the other hand, the sample handling mechanisms are controlled through the interaction between the step motors and an feedback unit attached to a personal computer. Naturally, a computer program is needed in order to send commends to move the X-Y table. For example, the control of the autofocus mechanism was achieved by comparing the development of particle edge in the images of different focal planes. It was found that an image is brought to focus when most of the edges is detected. In summary, the findings of this project have led to believe that the on-line image analysis can be used as a part of the coal cleaning process.

4887 (DOE/PC/92543–T8) **Micro-agglomerate flotation for deep cleaning of coal. Quarterly progress report, July 1–September 30, 1994.** Chander, S.; Hogg, R. Pennsylvania State Univ., University Park, PA (United States). Oct 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92543. Order Number DE95003571. Source: OSTI; NTIS; GPO Dep.

The goals of this research program are to demonstrate the technical and economic feasibility of a micro-agglomerate flotation process and to establish the essential criteria for reagent selection and system design and operation. We are investigating the use of a hybrid process – Micro-agglomerate flotation – which is a combination of oil-agglomeration and froth flotation. The basic concept is to use small quantities of oil to promote the formation of dense micro-agglomerates with minimal entrapment of water and mineral particles, and to use froth flotation to extract these micro-agglomerates from the water/dispersed-mineral phase. Since the floating units are agglomerates (about 30–50 μm in size) rather than individual coal particles (1–10 μm) the problems of froth overload and water/mineral carryover should be significantly alleviated. Micro-agglomerate flotation has considerable potential for the practical deep cleaning of coal on a commercial scale. In principle, it should be possible to achieve both high selectivity and high yield at reasonable cost. The process requires only conventional, off-the-shelf equipment and reagent usage (oil, surfactants, etc.) should be small. There are, however, complications. The process involves at least five phases: two or more solids (coal and mineral), two liquids (oil and water) and one gas (air). It is necessary to maintain precise control over the chemistry of the liquid phases in order to promote the interfacial reactions and interactions between phases necessary to ensure selectivity. The research program has been organized into several specific tasks : interfacial studies; emulsification; agglomerate growth and structure; and agglomerate flotation. Accomplishments are reported.

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Refer also to citation(s) 4916, 5547, 5661, 6198, 6204, 6206

4888 (CONF-920961–1) **Characterization of carbon-sulfur bond cleavage by axenic and mixed cultures of Rhodococcus rhodochrous IGTS8.** Kayser, K.J.; Bielaga, B.A.; Jackowski, K.; Oduson, O.; Kilbane, J. II. Institute of Gas Technology, Chicago, IL (United States). [1992]. 16p. Sponsored by Institute of Gas Technology, Chicago, IL (United States). From 5. international symposium on gas, oil and environmental biotechnology; Chicago, IL (United States); 21-24 Sep 1992. Source: OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616.

Growth assays reveal that Rhodococcus rhodochrous IGTS8 can utilize a wide range of organosulfur compounds as the sole source of sulfur. Compounds that are utilized include thiophenes, sulfides, disulfides, mercaptans, sulfoxides, and sulfones. None of the organosulfur compounds tested can serve as a carbon source. A convenient spectrophotometric assay (Gibbs assay) based on the chromogenic reaction of 2,6-dichloroquinone-4-chloroimide with aromatic hydroxyl groups was developed and used in conjunction with GC/MS analysis to examine the kinetics of carbon-sulfur bond cleavage by axenic and mixed cell cultures of Rhodococcus rhodochrous IGTS8. The desulfurization trait is expressed at uniform levels during the mid-exponential phase, reaches a maximum during idiophase, and then declines in stationary-phase cells. Desulfurization rates for dibenzothiophene (DBT) range from 8 to 15 μM of DBT/10^{12} cells/hour. Mixtures of genetically marked Rhodococcus rhodochrous IGTS8 and an organisms incapable of cleaning carbon-sulfur bonds in relevant test compounds, Enterobacter cloacae, were prepared in ratios that varied over six orders of magnitude. Growth studies revealed that Enterobacter cloacae was able to gain access to sulfur liberated from organosulfur compounds by IGTS8; however, cell-to-cell contact was required. These data also indicate that the desulfurization activity of IGTS8

cells in mixed cultures may be as much as 200-fold higher than in axenic cultures.

4889 (CONF-921037–12) **Scaleup of IGT MILDGAS Process to a process development unit.** Campbell, J.A.L. (Kerr-McGee Coal Corp., Oklahoma City, OK (United States)); Longanbach, J.; Johnson, R.; Underwood, K.; Mead, J.; Carty, R.H. Institute of Gas Technology, Chicago, IL (United States). [1992]. 7p. Sponsored by Institute of Gas Technology, Chicago, IL (United States);USDOE, Washington, DC (United States);Illinois State Government, Springfield, IL (United States). DOE Contract FC21-92MC27391. From 9. annual international Pittsburgh coal conference; Pittsburgh, PA (United States); 12-16 Oct 1992. Source: OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616.

The MILDGAS process is capable of processing both eastern caking and western non-caking coals to yield a slate of liquid and solid products. The liquids can be processed to produce: feedstocks for chemicals; pitch for use as a binder for electrodes in the aluminum industry; and fuels. Depending on the feed coal characteristics and the operating conditions, the char can be used as an improved fuel for power generation or can be used to make form coke for steel-making blast furnaces or for foundry cupola operations. The specific objectives of the program are to: design, construct, and operate a 24-tons/day adiabatic process development unit (PDU) to obtain process performance data suitable for design scaleup; obtain large batches of coal-derived co-products for industrial evaluation; prepare a detailed design of a demonstration unit; and develop technical and economic plans for commercialization of the MILDGAS process. In this paper, the authors present the process design of the PDU facility, a description of the expected product distribution and the project test plan to be implemented in the program.

4890 (DOE/MC/11076–3828) **Investigations into coal coprocessing and coal liquefaction.** Guffey, F.D. (Western Research Inst., Laramie, WY (United States)); Netzel, D.A.; Miknis, F.P.; Thomas, K.P.; Zhang, Tiejun; Haynes, H.W. Jr. Western Research Inst., Laramie, WY (United States); Wyoming Univ., Laramie, WY (United States). Dept. of Chemical Engineering. Jun 1994. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-86MC11076. Order Number DE94012266. Source: OSTI; NTIS; GPO Dep.

The conversion of coal to liquid suitable as feedstock to a petroleum refinery is dependent upon several process variables. These variables include temperature, pressure, coal rank, catalyst type, nature of the feed to the reactor, type of process, etc. Western Research Institute (WRI) has initiated a research program in the area of coal liquefaction to address the impact of some of these variables upon the yield and quality of the coal-derived liquid. The principal goal of this research is to improve the efficiency of the coal liquefaction process. Two different approaches are currently being investigated. These include the coprocessing of a heavy liquid, such as crude oil, and coal using a dispersed catalyst and the direct liquefaction of coal using a supported catalyst. Another important consideration in coal liquefaction is the utilization of hydrogen, including both externally- and internally-supplied hydrogen. Because the incorporation of externally-supplied hydrogen during conversion of this very aromatic fossil fuel to, for example, transportation fuels is very expensive, improved utilization of internally-supplied hydrogen can lead to reducing processing costs. The objectives of this investigation, which is Task 3.3.4, Coal Coprocessing, of the 1991–1992 Annual Research Plan, are: (1) to evaluate coal/oil pretreatment conditions that are expected to improve the liquid yield through more efficient dispersion of an oil-soluble, iron-based catalyst, (2) to characterize the coke deposits on novel, supported catalysts after coal liquefaction experiments and to correlate the carbon skeletal structure parameters of the coke deposit with catalyst performance as measured by coal liquefaction product yield, and (3) to determine the modes of hydrogen utilization during coal liquefaction and coprocessing. Experimental results are discussed in this report.

4891 (DOE/MC/24116–3928) **Development of an advanced, continuous mild gasification process for the production of co-products. Quarterly report, July 1994–September 1994.** O'Neal, G.W. Coal Technology Corp., Bristol, VA (United States). Oct 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-87MC24116. Order Number DE95000021. Source: OSTI; NTIS; GPO Dep.

The primary objective of this project is to develop an advanced continuous mild gasification process and product upgrading processes which will be capable of eventual commercialization. The program consists of four tasks. Task 1 is a literature survey of mild gasification processes and product upgrading methods and also a market assessment of markets for mild gasification products. Based on the literature survey, a mild gasification process and char upgrading method will be identified for further development. Task 2 is a bench-scale investigation of mild gasification to generate design data for a larger scale reactor. Task 3 is a bench-scale study of char upgrading to value added products. Task 4 is being implemented by building and operating a 1000-pound per hour demonstration facility. Task 4 also includes a technical and economic evaluation based on the performance of the mild gasification demonstration facility.

4892 (DOE/MC/26372–3863) **Development of hollow fiber catalytic membrane reactors for high temperature gas cleanup. Final report, September 1989–March 1994.** Ma, Yi Hua; Moser, W.R.; Pien, S.; Shelekhin, A.B. Worcester Polytechnic Inst., MA (United States). Dept. of Chemical Engineering. Jul 1994. 103p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-89MC26372. Order Number DE94004144. Source: OSTI; NTIS; GPO Dep.

The objective of this project was to develop economically and technically viable catalytic membrane reactors for high temperature, high pressure gaseous contaminant control in Integrated Gasification Combined Cycle (IGCC) systems. These catalytic membrane reactors decompose H_2S and separate the reaction products. The reactors were designed to operate in the hostile process environment of the IGCC systems, and at temperatures ranging from 500 to 1000°C. Severe conditions encountered in the IGCC process (e.g., 900°C, containing of H_2S, CO_2 and H_2O) make it impossible to use polymeric membranes in the process. A list of inorganic membranes that can be employed in the membrane reactor includes Pd metallic membranes, molecular-sieve glass membranes (PPG Industries), porous Vycor glass membranes and porous sol-gel derived membranes such as alumina, zirconia. Alumina and zirconia membranes, however, cannot withstand for a long time at high temperatures in the presence of water vapors. Palladium membranes are a very promising class of inorganic membranes for gas separations that is currently under development. In this project two different types of membranes were used in the design of the membrane reactor – molecular-sieve glass membrane and Vycor glass porous membrane.

4893 (DOE/MC/27233–3919) **Studies of in-situ calcium based sorbents in advanced pressurized coal conversion systems. Final report, June 1991–October 1994.** Katta, S.; Shires, P.J.; Campbell, W.M.; Henningsen, G. Kellogg (M.W.) Co., Houston, TX (United States). Oct 1994. 119p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-91MC27233. Order Number DE95000003. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project was to obtain experimental data on the reactions of calcium-based sorbents in both air-blown coal gasification systems and second generation fluid bed coal combustion systems (partial gasification) as well as stabilization of the spent sorbent produced. The project consisted of six tasks: Tasks 1 and 2 dealt mostly with project-related activities and preparation of test equipment, Task 3 – study on sulfidation of calcium-based sorbents, Task 4 – kinetic studies on calcium-catalyzed carbon gasification reactions, and Task 5 – oxidation of CaS present in LASHs and DASHs (mixtures of coal ash and limestone or dolomite respectively) to $CaSO_4$ and absorption of SO_2 on various solids, and Task 6 – economic evaluation of the most promising CaS oxidation method developed under this program. Experimental studies were conducted primarily to address Task 5 issues, and are discussed in this report.

4894 (DOE/MC/27240–T5) **Final report for "Production of mild gasification co-products" project.** Horne, D.A.; Castro, J.C.

SGI Fuels, Inc., La Jolla, CA (United States). 4 Dec 1994. 143p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-91MC27240. Order Number DE95003620. Source: OSTI; NTIS; GPO Dep.

The SGI International Liquids From Coal (LFC) Process is a mild pyrolysis, or mild gasification, treatment that upgrades low-rank coals by removing almost all of the moisture and a substantial portion of the volatile matter. The process produces two value-added co-products: a Coal Derived Liquid (CDL) and a solid Process Derived Fuel (PDF). A third co-product, a low-heating-value non-condensible gas, is recirculated and combusted in a commercial sized plant to provide drying and pyrolysis process heat. The LFC Process consists of three basic steps. The first step, drying, involves essentially inert gas convectively raising the coal temperature and removing most of the moisture. The drying temperature is limited to ensure that no hydrocarbon gases evolve, and the flow rate is limited below fluidization levels for most of the coal particles. The second step, pyrolysis, consists of additional inert gas heating that raises the temperature of the dried coal so that more than half of the volatile matter is removed under a controlled temperature history that is characteristic for each particular coal and customer demand. The third step, finishing or conditioning, consists of exposure to a cooling inert gas that quenches the pyrolysis reaction, followed by controlled exposure to oxygen for the purposes of stabilization. The processed solid char is then brought to moisture equilibrium (much less than the parent coal's equilibrium level), and, if necessary, a dust suppressant is added to the PDF. The PDF co-product is environmentally more attractive than the parent coal because a large fraction of the organic sulfur is removed with the volatile matter, and the heating value of the fuel is increased with a concurrent increase in combustion efficiency. When subjected to appropriate finishing steps, the PDF represents a stable, economically transportable, high-heat-value reactive combustion fuel with stable flame characteristics similar to natural gas.

4895 (DOE/METC–94/1002, pp. 71-83) **Development of an advanced, continuous mild gasification process for the production of co-products.** Wolfe, R.A. (Coal Technology Corp., Bristol, VA (United States)); Im, C.J.; Henkelman, M.R.; O'Neal, G.W.; McKinney, D.A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-87MC24116. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this project is to develop a continuous mild gasification process to convert highly caking coals to coal liquids, char and coke for near term commercial application. Coal liquids after fractionation can be blended with petroleum and used interchangeably with conventional fuels without modifications in gasoline and diesel engines. Char can be used as a carbon source in the production of ferroalloys and in mini-mills. In a step beyond the scope of the project, the plan is to finance, design and construct, in a partnership with others, a plant to product coal liquids, char and coke in the initial range of 250,000 tons/year.

4896 (DOE/METC–94/1002, pp. 84-90) **Value-added co-products from K-M/IGT Facility.** Carty, R.H.; Foster, H. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The overall objective of this project is to develop the IGT MILDGAS technology for near-term commercialization. The specific objectives of the program are to: (1) design, construct, and operate a 24-tons/day adiabatic process development unit (PDU) to obtain process performance data suitable for further design scaleup; (2) obtain batches of coal-derived co-products for industrial evaluation; (3) prepare a detailed design of a demonstration unit; (4) develop technical and economic plans for commercialization of the MILDGAS process.

4897 (DOE/PC/89783–T12) **Fundamental studies of catalytic processing of synthetic liquids. Final report.** Watson, P.R. Oregon State Univ., Corvallis, OR (United States). 15 Jun 1994. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-89PC89783. Order Number DE94018038. Source: OSTI; NTIS; GPO Dep.

Liquids derived from coal contain relatively high amounts of oxygenated organic compounds, mainly in the form of phenols and furans that are deleterious to the stability and quality of these liquids as fuels. Hydrodeoxygenation (HDO) using Mo/W sulfide catalysts is a promising method to accomplish this removal, but our understanding of the reactions occurring on the catalyst surface during HDO is very limited. Rather than attempting to examine the complexities of real liquids and catalysts we have adopted an approach here using model systems amenable to surface-sensitive techniques that enable us to probe in detail the fundamental processes occurring during HDO at the surfaces of well-defined model catalysts. The results of this work may lead to the development of more efficient, selective and stable catalysts. Above a S/Mo ratio of about 0.5 ML, furan does not adsorb on sulfided Mo surfaces; as the sulfur coverage is lowered increasing amounts of furan can be adsorbed. Temperature-programmed reaction spectroscopy (TPRS) reveals that C-H, C-C and C-O bond scission occurs on these surfaces. Auger spectra show characteristic changes in the nature and amount of surface carbon. Comparisons with experiments carried out with CO, H_2 and alkenes show that reaction pathways include – direct abstraction of CO at low temperatures; cracking and release of hydrogen below its normal desorption temperature; dehydrogenatin of adsorbed hydrocarbon fragments; recombination of C and O atoms and dissolution of carbon into the bulk at high temperatures. Performing the adsorption or thermal reaction in 10^{-5} torr of hydrogen does not change the mode of reaction significantly.

4898 (DOE/PC/90044–T2) **High octane ethers from synthesis gas-derived alcohols. Final technical report, September 25, 1990–December 24, 1993.** Klier, K.; Herman, R.G. Lehigh Univ., Bethlehem, PA (United States). May 1994. 167p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-90PC90044. Order Number DE95001146. Source: OSTI; NTIS; GPO Dep.

The objective of the research was to develop the methodology for the catalytic synthesis of ethers, primarily methyl isobutyl ether (MIBE) and methyl tertiary butyl ether (MTBE), directly from alcohol mixtures that are rich in methanol and 2-methyl-1-propanol (isobutanol). The overall scheme involves gasification of coal, purification and shifting of the synthesis gas, higher alcohol synthesis, and direct synthesis of ethers. The last stage of the synthesis involves direct coupling of synthesis gas-derived methanol and isobutanol that has been previously demonstrated by us to occur over superacid catalysts to yield MIBE and smaller amounts of MTBE at moderate pressures and a mixture of methanol and isobutene at low pressures. A wide range of organic resin catalysts and inorganic oxide and zeolite catalysts have been investigated for activity and selectivity in directly coupling alcohols, principally methanol and isobutanol, to form ethers and in the dehydration of isobutanol to isobutene in the presence of methanol. All of these catalysts are strong acids, and it was found that the organic and inorganic catalysts operate in different, but overlapping, temperature ranges, i.e. mainly 60–120°C for the organic resins and 90–175°C for the inorganic catalysts. For both types of catalysts, the presence of strong acid centers is required for catalytic activity, as was demonstrated by lack of activity of fully K^+ ion exchanged Nafion resin and zirconia prior to being sulfated by treatment with sulfuric acid.

4899 (DOE/PC/91050–T8-Vol.3) **Advanced direct coal liquefaction concepts - appendix.** Berger, D.J.; Parker, R.J.; Simpson, P.L. Canadian Energy Development, Inc., Edmonton, AB (Canada); Alberta Research Council, Edmonton, AB (Canada). Jul 1994. 307p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC91050. Order Number DE95004325. Source: OSTI; NTIS; GPO Dep.

This detailed appendix presents the results of direct coal liquefaction studies performed by the contractor. Several hundred tables summarizing the chemical compostion for runs of a bench scale reactor are presented.

4900 (DOE/PC/92208–T7) **Engineering development of advanced physical fine coal cleaning for premium fuel applications. Quarterly technical progress report No. 7, April 1,**

1994–June 30, 1994. Smit, F.J.; Moro, N.; Shields, G.L.; Jha, M.C. AMAX Research and Development Center, Golden, CO (United States). 5 Aug 1994. 147p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92208. Order Number DE95004312. Source: OSTI; NTIS; GPO Dep.

This project is a major step in the Department of Energy's program to show that ultra-clean coal-water slurry fuel (CWF) can be produced from selected coals and that this premium fuel will be a cost-effective replacement for oil and natural gas now fueling some of the industrial and utility boilers in the United States as well as for advanced combustors currently under development. The replacement of oil and gas with CWF can only be realized if retrofit costs are kept to a minimum and retrofit boiler emissions meet national goals for clean air. These concerns establish the specifications for maximum ash and sulfur levels and combustion properties of the CWF. This cost-share contract is a 51-month program which started on September 30, 1992. This report discusses the technical progress made during the 7th quarter of the project from April 1 to June 30, 1994. The project has three major objectives. The primary objective is to develop the design base for prototype commercial advanced fine coal cleaning facilities capable of producing ultra-clean coals suitable for conversion to coal-water slurry fuel for premium fuel applications. The fine coal cleaning technologies are advanced column flotation and selective agglomeration. A secondary objective is to develop the design base for near-term application of these advanced fine coal cleaning technologies in new or existing coal preparation plants for efficiently processing minus 28-mesh coal fines and converting this to marketable products in current economics. A third objective is to determine the removal of toxic trace elements from coal by advance column flotation and selective agglomeration technologies.

4901 (DOE/PC/93215–T4) **Novel microorganism for selective separation of coal from ash and pyrite. Fourth quarterly technical progress report, July 1, 1994–September 30, 1994.** Misra, M.; Smith, R.W. Nevada Univ., Reno, NV (United States). [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93PC93215. Order Number DE95004309. Source: OSTI; NTIS; GPO Dep.

This report summarizes the progress made during the fourth quarter of the research 9 project entitled "A Novel Microorganism for Selective Separation of Coal from Ash and Pyrite". The objective of this project is to study the effectiveness of a novel hydrophobic microorganism, Mycobacterium phlei (M. phlei), for the selective flocculation of coal from pyrite and ash forming minerals. During the reporting period, the adhesion of M phlei on the surface of quartz was investigated as a function of pH and conditioning time. Results showed that the little adhesion of M phlei onto quartz occurred. The amount of M phlei adsorbed onto the surface of quartz was less compared to coal. These results suggest that it would be possible to flocculate coal selectively from ash forming minerals. Flocculation tests conducted with Illinois No. 6 coal showed that rapid flocculation takes place in the pH range of 3-4. Flocculation efficiency is highly dependent upon the M. phlei concentration.

4902 (DOE/PC/93218–3) **Photochemical coal dissolution. Quarterly technical progress report, April 1, 1994–June 31, 1994.** Doetschman, D.C. State Univ. of New York, Binghamton, NY (United States). Dept. of Chemistry. [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93PC93218. Order Number DE94017379. Source: OSTI; NTIS; GPO Dep.

Development of a column-suspended coal photochemical apparatus continued through this quarter. Satisfactory teflon tubing connections were completed from solvent reservoir to reactor, from reactor to the Spec 21 spectrophotometer flow-cell and from the cell to the solvent still. Experiments with pyridine solvent and a whole, Lower Kittanning coal and a CS_2-N-methylpyrrolidinone-extracted Upper Freeport coal residue were done to gauge the solvent flow rates required in order to establish the desired optical densities. On the basis of these results, a peristaltic pump with computer-controllable flow rates between 0.5 μl/min and 41 ml/min was ordered. One unexpected and potentially problematic result of these development experiments is the precipitation of about 40 mg per gram of a yellow-brown solid on the irradiated surface of the reactor. X-ray diffraction, X-ray microprobe and elemental analyses of the material are under way. Preliminary indications point to an amorphous ash-free and low-sulfur material with a high >350 C melting point. Experiments to determine whether the formulation is simply pyridine photochemistry are also under-way.

4903 (ESTSC–000773IBMPC00) **CAVSIM. Underground Coal Gasification Program.** Britten, J.A., Thorsness, C.B. (Lawrence Livermore National Lab., CA, (United States)). Lawrence Livermore National Lab., CA (United States). 3 Mar 1989. Sponsored by USDOE, Washington, DC (United States). (NESC–9515). Source: ESTSC.

Description: IBM PC; DOS 3.2.; Microsoft FORTRAN 4.1; 7 5.25 Diskettes. CAVSIM does not work with MS FORTRAN 4.0x. CAVSIM uses the LSODE (NESC 592) ordinary differential equation solver, which is included. PLOT uses DIGLIB/PC (NESC 9639); this software is not included.

CAVSIM is a three-dimensional, axisymmetric model for resource recovery and cavity growth during underground coal gasification (UCG). CAVSIM is capable of following the evolution of the cavity from near startup to exhaustion, and couples explicitly wall and roof surface growth to material and energy balances in the underlying rubble zones. Growth mechanisms are allowed to change smoothly as the system evolves from a small, relatively empty cavity low in the coal seam to a large, almost completely rubble-filled cavity extending high into the overburden rock. The model is applicable to nonswelling coals of arbitrary seam thickness and can handle a variety of gas injection flow schedules or compositions. Water influx from the coal aquifer is calculated by a gravity drainage-permeation submodel which is integrated into the general solution. The cavity is considered to consist of up to three distinct rubble zones and a void space at the top. Resistance to gas flow injected from a stationary source at the cavity floor is assumed to be concentrated in the ash pile, which builds up around the source, and also the overburden rubble which accumulates on top of this ash once overburden rock is exposed at the cavity top. Char rubble zones at the cavity side and edges are assumed to be highly permeable. Flow of injected gas through the ash to char rubble piles and the void space is coupled by material and energy balances to cavity growth at the rubble/coal, void/coal and void/rock interfaces. One preprocessor and two postprocessor programs are included - SPALL calculates one-dimensional mean spalling rates of coal or rock surfaces exposed to high temperatures and generates CAVSIM input: TAB reads CAVSIM binary output files and generates ASCII tables of selected data for display; and PLOT produces dot matrix printer or HP printer plots from TAB output.

4904 (NEDO-C–9314) **Research and development promotion survey. Survey of the trend of clean coal technology in the U.S.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 256p. (In Japanese). Order Number DE95723111. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper investigates the trend of clean coal technology research and development in the U.S. through the 21st Biennial Conference on Carbon. The subjects investigated are an outline of the Clean Coal Technology Demonstration Program of U.S. Department of Energy, the developmental trend of integrated gasification combined cycle power generation (IGCC), the trend survey of the ENCOL mild gasification project, and coal-related research surveys in the 21st Biennial Conference on Carbon. In CCT program, the following are now worked on: 11 projects on coal-fired power generation systems; 20 on pollution control devices; 5 on coal processing; 5 on industrial application. Further, five IGCC demonstrative projects are being carried out. Three power plants are run by the combustion by advanced air-blown type gasification technology, and at four power plants a demonstrative operation is conducted of the subsystem for energy saving and high temperature gas cleaning. In the ENCOAL process, low-sulfur coal is heated, and process-derived fuel and coal-derived liquid are produced from it by using thermal cracking and mild gasification technology, LFC (liquids from coal technology). 167 refs., 86 figs., 55 tabs.

4905 (NEDO-C–9326) **Next generation coal utilization research and development. Advanced coal cleaning technology.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 326p. (In Japanese). Order Number DE95723109. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Coal cleaning technology is reported for fuel use and advanced use of coal. Coal cleaning technologies are selected through literature survey, and evaluation of performance of desulfurization/deashing are made through laboratory-scale experiments. As coal cleaning technology for fuel use, selected are fine particle dense media cyclone, column flotation, improved OA process (oil agglomeration), magnetic separation, and microbiological treatment. As coal cleaning technology for advanced coal use, alkali leaching and selected agglomeration. Results of the laboratory experiments indicate that the improved OA process and alkali leaching are comparatively applicable to any kind of coal, while fine particle dense media cyclone and magnetic separation are largely dependent on coal kind. Moreover, mineral composition to be removed is different by cleaning technology. In magnetic separation, for example, Fe, Ca, etc. decrease selectively, which shows that slugging at combustion is expected to be reduced. On the other hand, further study is needed for slurry fuel of clean coal and application to high added value fields. 80 refs., 180 figs., 78 tabs.

4906 (NEDO-C–9328) **Fiscal 1993 coal production/utilization technology promotion subsidy. Next generation coal utilization technology (survey of the trend of technology development and evaluation study by researchers in Japan).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 214p. (In Japanese). Order Number DE95723110. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper outlines a survey of the overall next generation coal utilization technology conducted by coal-related researchers in Japan. The studied subjects are as follows: as coal gasification/combustion combined cycle power generation process, technical survey of coal gasification and high efficiency power generation process, technical survey of research/development of topping combustion, oxidation mechanism of calcium sulfide and proposal of the char combustor, and evaluation of reaction activity of Ca-Mg based oxides upon high-temperature dry desulfurization. As to oxygen combustion, CO2 separation from flue gas from power generation plants. As coal thermal cracking technology, rapid thermal cracking, flash heating, pressurized fluidized bed catalytic thermal cracking, and catalytic reforming of thermal cracking volatile matter. Concerning advanced coal reforming technology, column flotation, nitrogen preremoval, liquefaction of low-grade coal using supercritical water, coal extraction using supercritical fluid, and utilization of coal as a solid radical catalyst. In addition, analyses of shapes of sulfur/nitrogen in desulfurization/denitrification and of crack growth in coking. 232 refs., 138 figs., 46 tabs.

4907 (NEI-DK–1749) **Hot gas cleaning.** Nielsen, D.V. (FLS miljoe a/s (Denmark)); Hoejlund Nielsen, P.E.; Sigurdardottir, I.D.; Christiansen, H. FLS Miljoe A/S, Valby (Denmark); Haldor Topsoee, Vedbaek (Denmark). May 1993. 135p. (In Danish, English). Contract ENS-1323/91-0011; Contract ENS-1323/90-0016. Order Number DE95723853. Source: OSTI; NTIS.

EFP-91; EFP-90.

In relation to thermal power plants, the status of hot gas cleaning and the properties of tin oxide and the compounds formed in an impure coal gas are discussed and results of experiments with SnO_2 masses are presented and evaluated. Possible cleaning processes with regard to a number of other compounds in the coal gas are considered. (AB)

4908 (ORNL/FMP–94/1, pp. 145-154) **Ceramic catalyst materials.** Sault, A.G. (Sandia National Labs., Albuquerque, NM (United States)); Gardner, T.J.; Srinivasan, S.; Hanprasopwattanna, A.; Datye, A.K. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Hydrous titanium oxide (HTO) ion-exchange materials show great potential as ceramic catalyst supports due to an inherently high ion-exchange capacity which allows facile loading of catalytically active transition metal ions, and an ability to be cast as thin films on virtually any substrate. While earlier work delineated optimum ion-exchange and activation procedures for noble metal catalysts supported on bulk HTO materials, current efforts focus on understanding and controlling HTO thin film formation on porous, high surface area substrates. The ability to tailor thin film properties offers a number of important advantages for catalytic applications. First, the use of a cheap, high surface area material as a substrate for HTO films improves the economics of HTO supported catalysts, as bulk HTO materials are substantially more expensive than conventional catalyst supports. Second, HTO thin film technology offers a convenient method for separately engineering the chemical (ion-exchange, activation, activity, etc.) and mechanical (porosity, pore size, surface area, mechanical strength, etc.) properties of catalytic materials. In order to take full advantage of HTO thin film technology, methods must be developed for forming continuous multilayer HTO films on high surface area substrates. We are addressing this problem by varying the properties of the sol-gel precursors used to form HTO films, and by altering HTO film deposition procedures. The effects of changes in film formation techniques on film properties are being investigated using transmission electron microscopy and isopropanol dehydration as a specific surface area probe. In order to assess the effects of changes in film properties on catalytic properties, ion-exchange and catalytic activity measurements are being made for a variety of catalytic reactions, including hydrogenation, hydrogenolysis (cracking) and upgrading of coal liquids.

4909 (PNL-SA–24684) **New catalysts for coal liquefaction and new nanocrystalline catalysts synthesis methods.** Linehan, J.C.; Matson, D.W.; Darab, J.G. Pacific Northwest Lab., Richland, WA (United States). Sep 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-9409168–10: Coal liquefaction and gas conversion contractors' review conference, Pittsburgh, PA (United States), 7-8 Sep 1994). Order Number DE95003136. Source: OSTI; NTIS; GPO Dep.

The use of coal as a source of transportation fuel is currently economically unfavorable due to an abundant world petroleum supply and the relatively high cost of coal liquefaction. Consequently, a reduction in the cost of coal liquefaction, for example by using less and/or less costly catalysts or lower liquefaction temperatures, must be accomplished if coal is to play an significant role as a source of liquid feedstock for the petrochemical industry. The authors and others have investigated the applicability of using inexpensive iron-based catalysts in place of more costly and environmentally hazardous metal catalysts for direct coal liquefaction. Iron-based catalysts can be effective in liquefying coal and in promoting carbon-carbon bond cleavage in model compounds. The authors have been involved in an ongoing effort to develop and optimize iron-based powders for use in coal liquefaction and related petrochemical applications. Research efforts in this area have been directed at three general areas. The authors have explored ways to optimize the effectiveness of catalyst precursor species through use of nanocrystalline materials and/or finely divided powders. In this effort, the authors have developed two new nanophase material production techniques, Modified Reverse Micelle (MRM) and the Rapid Thermal Decomposition of precursors in Solution (RTDS). A second effort has been aimed at optimizing the effectiveness of catalysts by variations in other factors. To this, the authors have investigated the effect that the crystalline phase has on the capacity of iron-based oxide and oxyhydroxide powders to be effectively converted to an active catalyst phase under liquefaction conditions. And finally, the authors have developed methods to produce active catalyst precursor powders in quantities sufficient for pilot-scale testing. Major results in these three areas are summarized.

0105 Products and By-Products

Refer also to citation(s) 4870, 4895, 4896, 4911

4910 (OCDO–95004423) **Utilization of high sulfur coal in carbon fiber production. Final report, April 1993–August 1994.** Burton, D.J.; Guth, J.R. Ohio Coal Development Office, Columbus, OH (United States). 12 Dec 1994. 27p. Sponsored by Ohio State Government, Columbus, OH (United States). Source: OSTI; Ohio Coal Development Office, 77 S. High Street, 25th Floor, P.O. Box 1001, Columbus, Ohio 43266-0001.

PYROGRAF-III™ is a highly graphitic vapor grown carbon fiber (VGCF) produced by the chemical vapor deposition of carbon on metallic catalysts in the temperature range of 1000°C. This is entirely different from commercial carbon fiber, which is made by first forming a filament and then graphitizing it in a high temperature oven. For PYROGRAF-III™ small amounts of sulfur in the form of hydrogen sulfide are added to the process to enhance the yield. This method of supplying the necessary sulfur is both expensive and hazardous since hydrogen sulfide is flammable, toxic, and corrosive. To supply the sulfur more economically and safely, high sulfur coal was proposed as a replacement for the hydrogen sulfide gas. Applied Sciences, Inc. is the sole producer of this material in pound quantities. The primary objective of research grant OCDO-922-8 was to demonstrate that Ohio's high sulfur coal can replace the expensive, toxic hydrogen sulfide in the production of vapor grown carbon fiber as well as become a partial or complete source of carbon. The secondary objective was to analyze the exhaust for the release of harmful sulfur compounds and to project the economic potential of the use of coal.

0106 Properties and Composition

Refer also to citation(s) 4886, 4932, 4985, 4986

4911 (CONF-9406232–1) **Thermodynamic and rheological properties of solid-liquid systems in coal processing.** Kabadi, V.N.; Mohandas, P.; Wang, Jinsong. North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Chemical Engineering. [1994]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91300. From Coal Research Contractors' review meeting; Pittsburgh, PA (United States); 8 Jun 1994. Order Number DE94017564. Source: OSTI; NTIS; GPO Dep.

The paper outlines background objectives, experimental methods and results for two studies: A group contribution method for the prediction of viscosity of coal-derived liquids, and Equation of state at high pressures for liquid aromatic compounds. Criteria for the new model, low pressure viscosity data set, new viscosity model for pure liquid aromatics, illustration of viscosity calculation using the model, and extension of the model to mixtures are discussed in the first study. Contents of the second study are: high pressure equation of state; new vapor pressure equation; and new correlation for saturated liquid densities.

4912 (CONF-940780–Vol.1, pp. 41-46) **Multi-parameter on-line coal bulk analysis.** Vourvopoulos, G. (Western Kentucky Univ., Bowling Green, KY (United States)); Humphrey, D.L. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract FG22-93PC93211. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Prompt Gamma Neutron Activation Analysis (PGNAA), has already been proven to be a viable technique for the on-line analysis of coal parameters such as the S, Cl, Fe etc. content of coal. The above technique utilizes very low energy (thermal) neutrons, usually emitted by a radioactive source. Two major drawbacks of the method as currently applied are (a) only those elements that can be excited by thermal neutron capture can be measured, and (b) ^{252}Cf radioactive sources are utilized which require a substantial shielding whether they are used or not. The utilization of pulsed fast-thermal neutrons will augment the PGNAA technique, and will allow the simultaneous on-line determination of the calorific value, % of volatile matter, and moisture of coal, along with all the parameters determined by PGNAA. Preliminary data indicate the feasibility of such a technique, at a cost comparable to the cost of a conventional PGNAA analyzer.

4913 (CONF-940780–Vol.2, pp. 431-438) **The physics of non-Newtonian liquid slurry atomization Part 2: Twin-fluid atomization of non-Newtonian liquids.** Mansour, A. (Carnegie Mellon Univ., Pittsburgh, PA (United States)); Chigier, N. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The changes in the physical processes of atomization as a result of adding a high molecular weight polymer in low concentrations to liquid have been studied. Both Newtonian and non-Newtonian liquids were investigated with particular emphasis on the non-Newtonian rheological characteristics. It was found that viscoelastic liquids are much more difficult to atomize than viscoinelastic liquids. Viscoinelastic liquids showed a breakup behavior similar to that of water sprays. Viscoelastic materials showed remarkably different breakup patterns. The ligaments were seen to undergo a very large stretching motion before they breakup, resulting in long threads of liquid attached to droplets. The normal stresses developed in viscoelastic materials are much higher than their associated shear stresses. Consequently, the development of the large normal stresses appears to be the most important rheological mechanism that inhibits breakup.

4914 (CONF-940780–Vol.2, pp. 591-599) **Viscoelastic behavior of beneficiated coal-water slurries and their atomization characteristics.** Ohene, F. (Grambling State Univ., LA (United States)); Bratton, T.; Rhone, Y. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Experimental data on the effects of CWS properties and air flow rate on mean drop size for simple pressure atomizers, were examined in our laboratory. A model equation which is derived based on the physical processes involved in air-pressure atomization is proposed. This equation demonstrates a good agreement with our experimental data.

4915 (CONF-940780–Vol.2, pp. 603-608) **Development of a phenomenological model for coal slurry atomization.** Dooher, J.P. (Adelphi Univ., Garden City, NY (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Highly concentrated suspensions of coal particles in water or alternate fluids appear to have a wide range of applications for energy production. For enhanced implementation of coal slurry fuel technology, an understanding of coal slurry atomization as a function coal and slurry properties for specific mechanical configurations of nozzle atomizers should be developed.

4916 (DOE/PC/92546–T8) **New concept for coal wettability evaluation and modulation. Technical progress report, July 1, 1994–September 30, 1994.** Hu, W. Utah Univ., Salt Lake City, UT (United States). Dept. of Metallurgy and Metallurgical Engineering. [1995]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-92PC92546. Order Number DE95004311. Source: OSTI; NTIS; GPO Dep.

This project is concerned with the new concept for coal surface wettability and floatability and modulation. The objective of this work is to study the fundamental surface chemistry features about the evaluation of the surface wettability and floatability of coal and pyrite, and establish a new separation strategy which could contribute to advanced coal-cleaning for premium fuel application.

4917 (DOE/PC/93051–T3) **Maintenance of the coal sample bank and database. Quarterly technical progress report, April 1, 1994–June 30, 1994.** Davis, A.; Glick, D.C. Pennsylvania State Univ., University Park, PA (United States). Coal and Organic Petrology Labs. 14 Oct 1994. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC93051. Order Number DE95004320. Source: OSTI; NTIS; GPO Dep.

This five year project is intended to ensure the availability of well-characterized, high-quality coal samples for public and private coal research. It continues support of the DOE Coal Sample Bank and Database at The Pennsylvania State University. Thirty coal samples will be collected, processed, packaged, and analyzed, and a resulting database will be maintained. These samples and data, as well as 26 samples collected under previous contracts, will be distributed to DOE contractors and others performing coal research. Samples will be chosen to maintain a sample bank of 56 coals representing the major U.S. coal fields and a variety of coal ranks and compositions. In addition to standard analyses, liquefaction tests and organic geochemical analyses will be performed. The samples will be stored to minimize deterioration, and will be monitored annually by proximate, sulfur forms, and gaseous oxygen analysis to evaluate their condition. These samples will be used for additional research on the influence of changes in surface chemistry on surface properties, the influence of sample deterioration on liquefaction properties, and the mechanisms of coal oxidation.

0108 Waste Management

Refer also to citation(s) 4893, 4992, 4995, 5030, 5488, 5651, 5665, 5676, 5687, 5688, 5689, 5690, 5693, 6544

4918 (CONF-940780–Vol.1, pp. 133-140) **Fundamental mechanisms in flue gas conditioning.** Snyder, T.R. (Southern Research Institute, Birmingham, AL (United States)); Bush, P.V. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-91PC90365. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The overall goal of this research project is to formulate a model describing effects of flue gas conditioning on particulate properties. This model will serve as a component of the performance models of particulate control devices where flue gas conditioning is used. By flue gas conditioning we mean any process by which solids, gases, or liquids are added to the combustor and/or the exhaust stream to the extent that flue gas and particulate properties may be altered. The model will be based on an understanding of how ash properties, such as cohesivity and resistivity, are changed by conditioning. Flue gas conditioning involves the modification of one or more of the parameters than determine the magnitude of forces acting on the fly ash particles, and can take place through many different methods. Modification of particulate properties can alter ash resistivity or ash cohesivity and result in improved control device performance. Changes to the flue gas, addition of particulate matter such as flue gas desulfurization (FGD) sorbents, or the addition of reactive gases or liquids can modify these properties. If we can better understand the mechanisms by which conditioning agents may result in significantly improved fine particle collection at lower capital and operating costs.

4919 (CONF-940780–Vol.1, pp. 141-147) **Bench-scale and pilot-plant evaluation of additives for improved particle collection in electrostatic precipitators.** Durham, M.; Baldrey, K.; Ebner, T.; Schlager, R.; Sjostrom, S. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The purpose of this research program is to identify and evaluate additives capable of increasing particle cohesion to improve collection efficiency in an ESP. Flue gas conditioning that changes the cohesive characteristics of the particles has the potential to improve collection efficiency because a large percentage of particulate emissions from a well-performing ESP is due to entrainment. Improved ESP performance should result if particle reentrainment could be reduced by making the particles "stickier" or more adhesive. This could produce a significant reduction in emissions from an ESP from the following mechanisms: (1) Reduced erosion-type reentrainment; (2) Reduced rapping emissions; (3) Reduced hopper reentrainment; (4) Increased agglomeration of fine particles. A flue gas conditioning system would have several advantages as a retrofit technology for improving the collection efficiency of ESPs. Conditioning is cost effective because it requires no modifications to the ESP. Current flue gas conditioning systems are relatively simple and can be applied to almost any ESP and installation requires minimal downtime of the boiler. Finally, it could also be used on new ESP designs to provide high collection efficiency with a reduced collection area.

4920 (CONF-940780–Vol.1, pp. 149-156) **Non-toxic additives for improved fabric filter performance.** Bustard, J.; Crater, G.; Ebner, T.; Sjostrom, S.; Slye, R. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The overall objective of this Phase I Small Business Innovation Research (SBIR) program was to demonstrate the feasibility of using non-toxic additive products as flue-gas conditioning agents for the improvement of particulate air toxics control and overall fabric filter performance. Current flue-gas conditioning agents such as SO_3/NH_3 have successfully improved fabric filter performance by reducing both particulate emissions and tube sheet pressure drop (Miller and Laudal, 1993); however, there are health, safety, and hazardous waste issues associated with them. Conditioning agents that would provide an alternative to SO_3/NH_3 were identified for evaluation in this program. Additive products were chosen that: (1) Would potentially increase particle cohesion; (2) Are not currently used as flue-gas conditioning agents; (3) Are non-toxic, and (4) Are cost competitive. Eleven new additives were evaluated in this laboratory test program. Four additives were identified as potential non-toxic conditioning agents that reduced outlet emissions by at least 90% compared with baseline conditions. This paper describes the test fixture, approach and results from these tests.

4921 (CONF-940780–Vol.1, pp. 157-163) **Catalytic fabric filtration for simultaneous NO_x and particulate control.** Weber, G.F. (Univ. of North Dakota, Grand Forks, ND (United States)); Dunham, G.E.; Laudal, D.L.; Ness, S.R.; Schelkoph, G.L. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The University of North Dakota Energy & Environmental Research Center (EERC); Owens-Corning Fiberglass Corporation (OCF); and Raytheon Engineers & Constructors (RE&C), conducted research to develop a catalytic fabric filter for simultaneous NO_x and particulate control. Funding for the project was provided by the U.S. Department of Energy/Pittsburgh Energy Technology Center (DOE/PETC), Consolidated Edison Company of New York Inc. (Con Edison), and the Empire State Electric Energy Research Corporation (ESEERCO). OCF provided catalyst-coated bags, fabric samples, and technical support as a cost share. The DOE/PETC program is intended to demonstrate technology showing significant advances in the state of the art using a process of a combination of processes capable of reducing NO_x emissions to 60 ppm or less. Other requirements include that a nonhazardous waste or a salable by-product be produced and that the concept be applicable to both new and retrofit coal-fired systems. A potential for a 50% cost savings must also be demonstrated in comparison

to a commercial selective catalytic reduction (SCR) process capable of meeting the 60-ppm NO_x emission limit.

4922 (CONF-940780–Vol.1, pp. 165-172) **Hollow fiber contactors for simultaneous SO_x/NO_x removal.** Bhown, A.S. (SRI International, Menlo Park, CA (United States)); Alvarado, D.B.; Pakala, N.R.; Ventura, S.; Sirkar, K.K.; Majumdar, S.; Bhaumik, D. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Control of SO_x and NO_x emissions from coal-fired utility and industrial boilers is a topic of growing national and international importance. Although a wide range of site-specific economic factors dictate the best choice of SO_x and NO_x control, removal of SO_2 by wet limestone scrubbing and removal of NO_x by selective catalytic reduction (SCR) are regarded as the best commercialized technologies for this application. A typical wet limestone plant requires approximately $100 to $120 of capital investment per kilowatt of electric power generating capacity and has power and miscellaneous operating costs in the range of 5 to 6 mils per kilowatt hour (kWh). The SCR process requires approximately $70 to $100 of capital investment per kilowatt of electric power generating capacity. Its operating costs, including ammonia consumption, is in the range of 1.8 to 2.2 mils per kWh. These costs can add approximately 20% to the final cost of generated electricity, a significant burden on rate payers. Our proposed research is aimed at developing (to a subscale prototype size) a new process for removal of SO_x and NO_x that is more than 20% less costly than limestone scrubbing of SO_2 and selective catalytic reduction of NO_x, removes at least 95% of the SO_x and 75% of the NO_x, and produces salable byproducts with no waste material. To accomplish this objective, we intend to develop a regenerable wet scrubbing process for SO_x and NO_x that exploits the advantages of a class of novel contacting devices, known as hollow fiber contactors (HFC), and that uses novel SO_x and NO_x absorption chemistry. The HFC devices will bring substantial capital cost savings to our process. The novel use of the contactors for regenerating the SO_2 scrubbing liquor and the novel NO_x absorption chemistry will help reduce the energy consumption.

4923 (CONF-940780–Vol.1, pp. 173-180) **Results of full-scale utility FGD SO_2 removal upgrade testing.** Blythe, G.M. (Radian Corp., Austin, TX (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI) have contracted with Radian Corporation to conduct full-scale testing, process modeling, and economic evaluations of six utility flue gas desulfurization (FGD) systems. The project objective is to evaluate low capital cost upgrades for achieving up to 98% sulfur dioxide (SO_2) removal efficiency in existing FGD systems. The six systems include a variety of absorber types and FGD operating modes. The testing is intended to demonstrate that upgrades such as performance additives, mechanical modifications, or a combination of these are viable means of increasing SO_2 removal at low cost. The cost-effectiveness of each upgrade is being evaluated on the basis of test results and/or process model predictions for upgraded performance, and utility-specific operating and maintenance costs. If high SO_2 removal at low cost is successfully demonstrated, SO_2 removal upgrades may be used by utilities with existing FGD systems as an approach for compliance with Phase 2 of Title IV of the Clean Air Act (CAA) Amendments of 1990. This paper provides an update of the results for efforts completed to date. Results from the first two sites were presented at last year's conference, so these sites will not be discussed again. This paper presents results from the third, fourth, and fifth sites. Efforts for the sixth site (NYSEG's Kintigh Station) have not yet begun, so this site is not discussed.

4924 (CONF-940780–Vol.1, pp. 181-188) **Development status of advanced sorbent injection process for SO_2 control.** Stouffer, M.R. (CONSOL Inc. Research & Development, Library, PA (United States)); Maskew, J.T.; Rosenhoover, W.A.; Withum, J.A. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-91PC90360. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

This paper describes the status of development of an advanced sorbent injection process for the control of SO_2 emissions from coal-fired power plants. The objective of the project is to develop a low-capital-cost process capable of over 90% SO_2 removal as a compliance option for the 1990 Clean Air Act Amendments. A complementary objective is to achieve sufficiently high sorbent utilization so that levelized costs are lower than wet limestone scrubbing costs over a wide range of coal types and plant sizes. The processes being developed, referred to as the Advanced Coolside process, involves the use of a contacting device which simultaneously removes fly ash and saturates the flue gas with water vapor. Sorbent is injected into the highly humid flue gas downstream of the contactor and is collected by the existing particular collector. High sorbent utilization is achieved by optimizing sorbent recycle. The originally established performance targets of 90% SO_2 removal and 60% sorbent utilization were exceeded in 1000 acfm pilot plant operations. The 90% SO_2 removal target was achieved at sorbent utilizations of 70-75%; up to 99% SO_2 removal was attained at over 60% sorbent utilization. An interim process approaches for process improvement. This paper discusses recent process improvements and the results of a revised economic study which shows that these improvements can substantially reduce cost. Projected capital costs are less than 1/2 of those of wet limestone scrubbing. Levelized SO_2 control cost is 20% lower than wet FGD for a 260 MWe plant burning a 2.6% sulfur coal. The study also indicated areas for future research.

4925 (CONF-940780–Vol.1, pp. 189-196) **Overview of recent research activities at EPRI's High Sulfur Test Center - April 1993 to March 1994.** Moser, R.E.; Owens, D.R.; Stohs, M. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The Electric Power Research Institute's High Sulfur Test Center (EPRI's HSTC) has been in operation for nearly seven years. During this time, numerous test programs have been performed with the purpose of aiding the utility industry in developing more cost-effective and environmentally sound emission control technologies for use with high-sulfur coals. Funding for the HSTC is provided, in part, by the HSTC cosponsors: New York State Electric and Gas (host utility), Empire State Electric Energy Research Corporation, Electric Power Development Corporation, the U.S. Department of Energy, Babcock & Wilcox, and ABB Environmental Systems. The overall goals of the HSTC wet flue gas desulfurization (FGD) research program are to investigate ways of reducing the operating costs and improving the reliability of existing lime and limestone wet FGD systems, while also investigating promising new process concepts that can be incorporated into new system designs. Two wet scrubber systems are currently available for testing: a 4-MWe pilot unit and a 0.4-MWe "mini-pilot" unit. The two systems have a common reagent preparation system and upstream particulate control device (ESP or reverse-gas fabric filter). Detailed process descriptions of these systems have been presented previously.

4926 (CONF-940780–Vol.1, pp. 197-203) **FGD waste disposal cost and sensitivity analysis.** Ratafia-Brown, J.; Gorokhov, V. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and

environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Increasing waste disposal charges, resulting from stricter federal and state disposal regulations and reduced landfill availability, are expected to reduce the current economic advantage that the throw-away FGC technologies have over the byproduct-producing processes. The overall purpose of this project is to try to establish realistic FGC waste disposal costs and to estimate their potential impact on the comparative lifecycle economics of several low-cost throw-away FGC processes versus several advanced, regenerable processes that produce marketable byproducts. Most of the project work focused on a review of waste disposal cost estimation for the 16 states with the highest coal-fired generating capacity, and cost projection results out to the year 2010 (and projection methodologies) for future waste disposal charges. This paper is separated into four major topics: (1) Federal and state fossil fuel combustion (FFC) waste disposal regulations, (2) basic information about disposal technologies and cost of FFC waste disposal systems, (3) comparative analysis of the cost impact of different disposal practices which may be required by current state regulations, and (4) comparative lifecycle cost analysis for competing flue gas cleanup technologies based on the sensitivity to waste disposal charges.

4927 (CONF-940780–Vol.1, pp. 207-214) **Development of a metal chelate additive for use in wet limestone systems to remove simultaneous SO_2 and NO_x from flue gas.** Chang, S.G. (Lawrence Berkeley Lab., CA (United States)); Pham, E.; Littlejohn, D.; Shi, A.Y. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The combustion of fossil fuels generates SO_2 and NO_x pollutants which cause acid rain and urban smog. Existing flue gas desulfurization scrubbers involve wet limestone processes which are efficient in SO_2 control but are incapable of removing water-insoluble nitric oxide. Moreover, the current technique for the post combustion control of nitrogen oxides emissions, ammonia-based selective catalytic reduction, suffers from various problems. These include poisoning of the catalysts from flyash rich in arsenic or alkali, disposal of spent toxic catalysts, ammonia slip, and the effects of ammonia byproducts on plant components downstream from the reactor. To circumvent separate control schemes for both SO_2 and NO_x pollutants, we have developed an iron(II) thiochelate complex which promotes the solubility of NO in aqueous solution by rapidly and efficiently absorbing NO to form iron nitrosyl complexes. The bound NO is then converted via electrochemical reduction to ammonia to regenerate the active iron(II) catalyst for continued NO capture. The results suggest that this metal thiochelate-based process can be readily integrated into existing wet limestone scrubbers for the simultaneous removal of SO_2 and NO_x.

4928 (CONF-940780–Vol.2, pp. 533-540) **Ceramic filter for fine particulate control.** Bishop, B.A. (Ceramem Corp., Waltham, MA (United States)); Abrams, R.F.; Goldsmith, R.L. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract FG02-90ER80897. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

A novel, high efficiency, compact ceramic filter has been developed for particulate removal from flue gas and hot gas streams. These filters were tested in a 5,000 ACFM, 1.5 MW flue gas pilot plant. Due to filter fouling by a thin layer of cementitious ash, the initial filter pressure drop after backpulse cleaning could not be completely recovered. Based on experimental results from other successful filtration runs and a steady state gas flow pressure drop analysis, it was determined that parasitic pressure losses due to flow down the small, 12 inches long filter passageways minimized the efficiency of the gas backpulses in removing deposited ash layers. Preliminary results on an incinerator application have indicated that minimizing the channel flow pressure drop in the filters leads to effective filter regeneration.

4929 (CONF-940780–Vol.2, pp. 583-590) **Reduction of nitrogen oxides in the NOXSO Process.** Zhou, Q. (NOXSO Corp., Bethel Park, PA (United States)); Haslbeck, J.; Neal, L.; Harkins, S.; Chang, A.; Black, J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The NOXSO Process is a dry, post-combustion flue gas treatment technology which can simultaneously remove 90% NO_x/SO_2 using a dry, regenerable sorbent. In the process, NO_x and SO_2 are adsorbed by a fluidized bed of sorbent in an adsorber at a temperature of 120°C. The NO_x is then desorbed by heating the sorbent in a heater and returned to the boiler to be reduced to nitrogen and oxygen. This is called NO_x recycle. SO_2 is regenerated at 620°C using a reducing gas in a regenerator and converted to a sulfur byproduct in a Claus plant. After sulfur regeneration, the sorbent is cooled and transported to the adsorber for reuse. The schematic of the NOXSO Process is shown.

4930 (DOE/MC/28060–3856) **Land application uses of dry FGD by-products. [Quarterly report, January 1, 1994–March 31, 1994].** Dick, W.A.; Beeghly, J.H. Dravo Lime Co., Pittsburgh, PA (United States). [1994]. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-91MC28060. Order Number DE94017582. Source: OSTI; NTIS; GPO Dep.

This report contains three separate monthly reports on the progress to use flue gas desulfurization by-products for the land reclamation of an abandoned mine site in Ohio. Data are included on the chemical composition of the residues, the cost of the project, as well as scheduling difficulties and efforts to allay the fears of public officials as to the safety of the project. The use of by-products to repair a landslide on State Route 541 is briefly discussed.

4931 (DOE/MC/28060–3949) **Land application uses of dry FGD by-products. OCDO monthly project status report.** Beeghly, J.H.; Dick, W.A. Dravo Lime Co., Pittsburgh, PA (United States). Apr 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-91MC28060. Order Number DE95004302. Source: OSTI; NTIS; GPO Dep.

Progress in developing uses of dry FGD by-products (coal by-products) are briefly summarized. Environmental impact studies for these applications are underway.

4932 (DOE/MC/30251–3938) **High-volume, high-value usage of flue gas desulfurization (FGD) by-products in underground mines. Phase 1: Laboratory investigations; Quarterly report, April–June 1994.** Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research. Sep 1994. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-93MC30251. Order Number DE95000032. Source: OSTI; NTIS; GPO Dep.

Activities included the collection of a second sample set consisting of scrubber material, fly ash and lime from a conventional scrubber system. The chemical and physical characterization of the Archer Daniel Midland (ADM) FBC material included particle size analysis and elemental analysis. Field trips were made to the landfill site managed by the Freeman United Coal Company where the ADM material is currently being managed. The objective of the trips was to examine the changes of the material with time. The fresh hydrated material was characterized by high strength and hardness and contained ettringite and anhydrite. The older material was weaker and contained gypsum and calcite and a partially decomposed ettringite. The goal of the geotechnical characterization is to develop a mix design appropriate for mine emplacement. Evaluation of four different types of mixes are being evaluated: (1) FGD

mixed with water and not subjected to prehydration, (2) FGD prehydrated for 24 hours and then mixed with water, (3) FGD mixed with bottom ash from the same location, and (4) FGD mixed with a typical Midwest fly ash. Based on the evaluation completed to date the prehydrated offers the most promise for providing a mix design that can permit relatively high strengths and low mixing and curing temperatures. The final survey of the field site was completed and coring and pressure testing of the strata in the immediate vicinity of the proposed adits was completed. A literature review of the factors which control spontaneous coal combustion was also completed. It was determined that the Princess No.3 Mine has a low to moderate potential for spontaneous combustion.

4933 (DOE/METC–94/1002, pp. 299-305) **Commercialization of previously wasted coal mine gob gas and coalbed methane.** Sakashita, B.J. (Resource Enterprises Inc., Salt Lake City, UT (United States)); Deo, M.D. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FG21-92MC29254. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives of the project were to: (i) conduct an assessment of the commercial potential of the gob gas and coalbed methane resources associated with coal mining operations, and (ii) evaluate alternative gas utilization technologies. The end results to be achieved are the exploitation of an energy resource that is presently being wasted as it is vented to atmosphere and the mitigation of methane liberations for improved environmental quality.

4934 (DOE/METC–94/1008-Vol.2, pp. 637-645) **Development of sorbents for high-temperature desulfurization in moving-bed systems.** Ayala, R.E. (GE Corporate Reseach and Development, Schenectady, NY (United States)); Chuck, T.; Gal, E.; Gupta, R.P. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-88MC25003. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objective of the option 3 program within this contract is to develop chemically reactive and mechanically durable mixed-metal oxide sorbent formulations that are suitable for moving-bed, high-temperature, desulfurization of coal gas. One optimum formulation will be evaluated in a pressurized 50-cycle bench-scale test. Work on zinc ferrite formulations was performed under the base program. Work on zinc titanate formulations was initiated under the option 2 program and is continued under the present option 3 program along with testing of other mixed-metal oxides.

4935 (DOE/METC–94/1008-Vol.2, pp. 646-653) **Fluidized-bed sorbents.** Gupta, R.P. (Research Triangle Institute, Research Triangle Park, NC (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-88MC25006. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of this project are to identify and demonstrate methods for enhancing long-term chemical reactivity and attrition resistance of zinc oxide-based mixed metal-oxide sorbents for desulfurization of hot coal-derived gases in a high-temperature, high-pressure (HTHP) fluidized-bed reactor. Specific objectives of this study are the following: Investigating various manufacturing methods to produce zinc ferrite and zinc titanate sorbents in a particle size range of 50 to 400 μm; Characterizing and screening the formulations for chemical reactivity, attrition resistance, and structural properties; Testing selected formulations in an HTHP bench-scale fluidized-bed reactor to obtain an unbiased ranking of the promising sorbents; Investigating the effect of various process variables, such as temperature, nature of coal gas, gas velocity, and chemical composition of the sorbent, on the performance of the sorbent; Life-cycle testing of the superior zinc ferrite and zinc titanate formulations under HTHP conditions to determine their long-term chemical reactivity and mechanical strength; Addressing various reactor design issues; Generating a database on sorbent properties and performance (e.g., rates of reaction, attrition rate) to be used in the design and scaleup of future commercial hot-gas desulfurization systems; Transferring sorbent manufacturing technology to the private sector; and Producing a large batch (in tonnage quantities) of the sorbent to demonstrate commercial feasibility of the preparation method.

4936 (DOE/METC–94/1008-Vol.2, pp. 654-661) **Fluidization studies using Phillips Z-SORB sorbent.** Gupta, R.P. (Research Triangle Institute, Research Triangle Park, NC (United States)); Khare, G.P.; Delzer, G.A.; Kubicek, D.H. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-88MC25006. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of this project are to determine the long-term chemical reactivity and mechanical durability of a fluidized version of Phillips Petroleum Company's (PPCo's) proprietary Z-SORB sorbent for the desulfurization of coal-derived gases in a high-pressure (20 atm) fluidized-bed reactor under simulated U-Gas conditions and at a moderate operating temperature of 538°C (1,000°F).

4937 (DOE/METC–94/1008-Vol.2, pp. 662-667) **Desulfurization sorbent development at the Morgantown Energy Technology Center.** Siriwardane, R.V. (Morgantown Energy Technology Center, WV (United States)); Grimm, U.; Poston, J.; Monaco, S. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project is to develop regenerable sorbents for hot gas desulfurization in IGCC systems. The major criteria for the development of novel sorbents included reasonable chemical reactivity and physical durability during repeated sulfidation and regeneration cycles.

4938 (DOE/METC–94/1008-Vol.2, pp. 668-678) **Stabilization of spent calcium-based sorbent.** Katta, S. (M.W. Kellogg Co., Houston, TX (United States)); Henningsen, G.B. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-91MC27233. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project is to obtain experimental data on the reactions of calcium-based sorbents applicable to both air-blown coal gasification systems and second generation fluid bed coal combustion systems (partial gasification). The project is a 40-month effort. A key technical issue for the utilization of calcium sorbents in advanced coal technologies is the subsequent stabilization of the solid wastes (calcium sulfide/ash) produced by such systems.

4939 (DOE/METC–94/1008-Vol.2, pp. 727-735) **Development of hollow fiber catalytic membrane reactors for high temperature gas cleanup.** Ma, Y.H. (Worcester Polytechnic Institute, MA (United States)); Moser, W.R.; Pien, S.; Shelekhin, A.B. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-89MC26372. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review*

meeting. Volume 2. 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objective of this project was to develop economically and technically viable catalytic membrane reactors for high temperature, high pressure gaseous contaminant control in IGCC systems. These catalytic membrane reactors were used to decompose H_2S and separate the reaction products. The reactors were designed to operate in the hostile process environment of the IGCC systems, and at temperatures ranging from 500 to 1000°C.

4940 (DOE/METC–94/1008-Vol.2, pp. 736-743) **Thermal/chemical degradation of inorganic membrane materials.** Krishnan, G.N. (SRI International, Menlo Park, CA (United States)); Sanjurjo, A.; Damle, A.S.; Wood, B.J.; Lau, K.H. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-92MC28053. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The overall objective of this program is to evaluate the long-term thermal and chemical degradation of inorganic membranes that are being developed to separate gaseous products produced by the gasification or combustion of coal in fixed-, fluidized-, and entrained-bed gasifiers, direct coal-fired turbines, and pressurized-fluidized-bed combustors. Specific objectives of this program are to (1) quantify the extent of the degradation process for the three most detrimental mechanisms by performing laboratory-scale experiments, and (2) develop a predictive model for membrane degradation under operating conditions.

4941 (DOE/METC/C–94/7147) **Granular filtration in a fluidized bed.** Mei, J.S.; Yue, P.C.; Halow, J.S. USDOE Morgantown Energy Technology Center, WV (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). (CONF-9406131–65: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). Order Number DE95003384. Source: OSTI; NTIS; GPO Dep.

Successful development of advanced coal-fired power conversion systems often require reliable and efficient cleanup devices which can remove particulate and gaseous pollutants from high-temperature high-pressure gas stream. A novel filtration concept for particulate cleanup has been developed at the Morgantown Energy Technology Center (METC) of the U.S. Department of Energy. The filtration system consists of a fine metal screen filter immersed in a fluidized bed of granular material. As the gas stream passes through the fluidized bed, a layer of the bed granular material is entrained and deposited at the screen surface. This material provides a natural granular filter to separate fine particles from the gas stream passing through the bed. Since the filtering media is the granular material supplied by the fluidized bed, the filter is not subjected to blinding like candle filters. Because only the in-flowing gas, not fine particle cohesive forces, maintains the granular layer at the screen surface, once the thickness and permeability of the granular layer is stabilized, it remains unchanged as long as the in-flowing gas flow rate remains constant. The weight of the particles and the turbulent nature of the fluidized bed limits the thickness of the granular layer on the filter leading to a self-cleaning attribute of the filter. Batch mode filtration performance of the filter was first reported at the Ninth Annual Coal-Fueled Heat Engines, Advanced Pressurized Fluidized-Bed Combustion, and Gas Stream Cleanup Systems Contractors Review Meeting.

4942 (DOE/PC/91295–T12) **A novel, integrated treatment system for coal waste waters. Quarterly report, June 2, 1994–September 1, 1994.** Wang, H.Y.; Srinivasan, K.R. Michigan Univ., Ann Arbor, MI (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91295. Order Number DE95003572. Source: OSTI; NTIS; GPO Dep.

The aims of this study are to develop, characterize and optimize a novel treatment scheme that would be effective simultaneously against the toxic organics and the heavy metals present in coal conversion waste waters. A specific goal of the study is to remove and recover cationic and anionic heavy metals from aqueous solutions and coal conversion waste waters using modified-clay adsorbents developed in this study. We have carried out multi-step adsorption/desorption studies with these adsorbents which indicate that modified-smectites can be repeatedly used up to 5 times with less than 15% loss in their potency. Thus, it would appear that the DT coatings on DT-modified clays are quite stable. Continuous leaching experiments have been undertaken to verify the stability of adsorbed DT on DT-modified smectites, HCDT and MONT-DT. Potentiometric titrations and ESA measurements at different time intervals have been used respectively to determine the surface charge density and the sign of surface charge of DT-modified smectites. Our results show that, even after 44 hours of continuous leaching of DT-modified smectites by deionized water, the surface charge density as measured by pH titration is lower by less than 10% of its initial value. Further more, the surface charge remains positive in the pH range of 9.5-3.0. These results are in agreement with our earlier results based on Ninhydrin assay and organic carbon analysis of the same DT-modified smectites.

4943 (DOE/PC/91344–T9) **Advanced separation technology for flue gas cleanup. Quarterly technical report No. 9, April 1994–June 1994.** Bhown, A.S. (SRI International, Menlo Park, CA (United States)); Alvarado, D.; Pakala, N.; Ventura, S.; Sirkar, K.K.; Majumdar, S.; Bhaumick, D. SRI International, Menlo Park, CA (United States). Aug 1994. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC91344. Order Number DE95004319. Source: OSTI; NTIS; GPO Dep.

The objective of this work is to develop a novel system for regenerable SO_2 and NO_x scrubbing of flue gas that focuses on (a) a novel method for regeneration of spent SO_2 scrubbing liquor and (b) novel chemistry for reversible absorption of NO_x. In addition, high efficiency hollow fiber contactors (BFC) are proposed as the devices for scrubbing the SO_2 and NO_x from the flue gas. The system will be designed to remove more than 95% of the SO_x and more than 75% of the NO_x from flue gases typical of pulverized coal-fired power plants at a cost that is at least 20% less than combined wet limestone scrubbing of SO_x and selective catalytic reduction of NO_x. In addition, the process will make only marketable byproducts, if any (no waste streams).

4944 (Juel–2935) **Investigations into the recycling or the dumping of coal ash and flue gas purification residues.** Spoo, H. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Sicherheitsforschung und Reaktortechnik; Technische Hochschule Aachen (Germany). Jul 1994. 194p. (In German). Order Number DE95731372. Source: OSTI; NTIS (US Sales Only).

The firing of coal in large-scale power plants and co-generation plants in Germany produces approx. 7 million tonnes of ash per year. In addition, there are approx. 4 million tonnes of flue gas purification residues (FGD products), about 2.5 million tonnes of which are produced in coal-fired plants. A prerequisite for the recycling of these by-products is the determination of their chemical composition as well as of certain mineralogical and soil mechanics parameters. The important parameters include ignition loss, grain size distribution, free lime content, compression behaviour and compressive strength. With a view to the recycling or dumping, environmentally relevant parameters also play a role. Permeability and leaching behaviour are of particular importance here. Permeability was determined in the triaxial cell. It became evident that the triaxial test is also suitable for recording and describing the leaching behaviour. Thus the permeability factor and the leaching behaviour can be determined using just one test. When the leaching behaviour is determined in the triaxial cell, mineralogical and permeability-reducing effects in particular are recorded. This is not possible with the DEV S4 process. Permeability and thus leachability decrease, the longer the residue is stored. This was demonstrated by means of Hg pressure porosimeter measurements. The porosity and hence also the permeability of cement-consolidate ashes and FGD products are clearly reduced by adding chloride-bearing waste water from flue gas purification processes instead of fully demineralised water. The K_f-values achieved are within the range of the values required for the sealing of dumps, which means that use in dumps is possible. The addition of FGD waste water also causes the uniaxial compressive strength to be increased substantially. This is important with regard

to the recycling of cement-consolidated by-products as filling material in the mining industry. (orig.)

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Refer also to citation(s) 4958, 4993, 5678, 5679, 5681, 5682, 5683, 5684, 5685, 5686, 6606

4945 (CONF-940780–Vol.1, pp. 219-227) **Potential for terrestrial disposal of carbon dioxide in the U.S.** Winter, E.M. (Pittsburgh Energy Technology Center, PA (United States)); Bergman, P.D. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Abandoned oil and natural gas reservoirs and deep aquifers were investigated as potential disposal sites for CO_2. Currently abandoned oil and gas reservoirs could hold approximately 2.9 Gt of CO_2. Since the annual CO_2 emissions from utility power plants is 2 Gt, these reservoirs would be filled in less than 1.5 years. The volume corresponding to ultimate reserves of oil and gas would hold roughly 100 Gt of CO_2. Therefore, the ultimate capacity for CO_2 storage is approximately 50 years. Over half of the CO_2 is emitted east of the Mississippi River, and most of the potential disposal sites are west of the Mississippi. Because of the high cost of transporting CO_2 by pipeline over long distances, only a small fraction of the reservoir capacity would be useful. The capacity of deep aquifers for CO_2 disposal is highly uncertain. A rough estimate for the U.S., derived from global estimates, is 5-500 Gt of CO_2.

4946 (CONF-940780–Vol.1, pp. 229-244) **An overview of CO_2 recovery technologies.** Radziwon, A.S. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Growing concerns about global climate change may prompt regulators to limit the emissions of CO_2 from power plants. Efficiency improvements and fuel switching, although helpful can have only a limited impact. It may therefore become necessary to remove CO_2 from flue gas and to recover it for long term storage or disposal. Several technically viable technologies exist, but all are expensive and require large amounts of parasitic power. The most energy efficient system is estimated to use 35% of the host plant's power.

4947 (CONF-940780–Vol.1, pp. 245-253) **The Carnol process for methanol production and utilization with reduced CO_2 emissions.** Steinberg, M. (Brookhaven National Lab., Upton, NY (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

A first order comparative mass and energy analysis is made of alternative processes for the production and utilization of methanol. Conventional reforming of natural gas with steam and CO_2 indicates a yield of approximately 1 mol of methanol per mol of methane and a net emission of 1 mol of CO_2 per mol of methanol. Three new processes called Carnol I, Carnol II and Carnol III utilize CO_2 as a feedstock in conjunction with hydrogen produced from the thermal decomposition of methane can reduce CO_2 emission compared to the conventional process by 35%, 88%, and 100% respectively while reducing methanol production by 11%, 35%, and 39% respectively. The carbon from methane decomposition can be sequestered or sold as a commodity. The methanol can be used in the transportation sector as an alternative efficient fuel. A preliminary economic estimate indicates the equivalent cost for reduction of CO_2 to be less than estimates for removal, recovery, and disposal of CO_2 from power plant stack gas. The Carnol process leverages the CO_2 reduction both from central fossil fuel fired power plants and the transportation sector. The Carnol process assists in the reduction of CO_2 emission from an otherwise impossible collection of CO_2 from highly dispersed heat engine and small scale fuel users.

4948 (CONF-940780–Vol.1, pp. 255-256) **Systems and economic analysis of microalgae ponds for conversion of CO_2 to biomass.** Benemann, J.R. (Univ. of California, Berkeley, CA (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Microalgae cultivation in large open ponds is the only photosynthetic process likely to directly utilize power plant flue gas CO_2 for production of biomass. The algal biomass can be converted into substitutes for fossil fuels, in particular liquid fuels such as biodiesel (vegetable oil methyl or ethyl esters), thus reducing atmospheric CO_2 levels and the potential for global warming. This concept is being investigated, among others, at the National Renewable Energy Laboratory at Golden Colorado, with support from PETC. Microalgae biomass is currently being produced for food supplements in the U.S. at three commercial facilities, each about 10 hectare in size and producing several hundred tons of algae at a cost of over $10,000/ton. In scale, productivities and costs, microalgae biomass production technology must advance by an order of magnitude to be considered as an alternative fuel source and CO_2 mitigation technology.

4949 (CONF-940780–Vol.1, pp. 267-274) **A study of toxic emissions from a coal-fired power plant demonstrating the ICCT CT-121 FGD project.** Hargrove, O.W. Jr. (Radian Corp., Austin, TX (United States)); Maxwell, D.P.; Williams, W.A.; Flora, H.B.; Durham, M.D. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy is performing comprehensive assessments of toxic emissions from eight selected coal-fired electric utility units. These data are being collected in response to the Clean Air Act Amendments of 1990, which require that EPA conduct a study of the emissions of hazardous air pollutants (HAPs) from electric utility power plants, and these emissions be evaluated for potential health risks. The data will be compiled and combined with similar data that are being collected as part of the Field Chemical Emissions Monitoring program sponsored by the Electric Power Research Institute (EPRI) and will then be furnished to the U.S. Environmental Protection Agency for emissions factor and health risk determinations. The assessments of emissions involve the collection and analysis of samples from the major input and output streams of each of the eight power plants for selected hazardous pollutants contained in Title III of the Clean Air Act. Additional goals of these assessments are to collect data from the selected plants that may be helpful in characterizing removal efficiencies of pollution control subsystems for these selected pollutants and to determine the concentrations associated with the particulate fraction of the flue gas stream as a function of particle size. Material balances will be performed for selected pollutants around the entire power plant and numerous subsystems to determine the fate of hazardous substances in each utility system and to provide an overall check on data quality. Radian Corporation was selected to perform one toxics assessment at a plant demonstrating an Innovative Clean Coal Technology (ICCT) Project. The selected site is in the Plant Yates Unit No. 1 of Georgia Power Company, which includes the ICCT CT-121 demonstration project.

4950 (CONF-940780–Vol.1, pp. 275-285) **Major findings and results from comprehensive assessment of emissions**

from two coal-fired power plants. Jackson, B.L.; Devito, M.S. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy Pittsburgh Energy Technology Center (DOE) sponsored a collaborative effort to characterize toxic emissions and air pollution control equipment (APCE) performance at electric utilities firing bituminous, subbituminous, and lignite coal. This paper presents the major results of the investigative activities of Roy F. Weston, Inc. (WESTON) and its team subcontractors CARNOT, CONSOL Inc. Research and Development, and Triangle Laboratories, Inc. at two of the eight power plant configurations studied by contractors in 1993 under project Phase I: Minnesota Power Company's Clay Boswell Energy Center Unit 2 (Boswell), located in Cohasset, Minnesota, and Illinois Power Company's Baldwin Power Station Unit 2 (Baldwin), located in Baldwin, Illinois.

4951 (CONF-940780–Vol.1, pp. 287-294) **Comprehensive assessment of air toxics at Springerville Generating Station.** Dismukes, E.B.; Bush, P.V. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-93PC93254. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The DOE's Pittsburgh Energy Technology Center issued a solicitation in February 1992 for Comprehensive Assessment of Air Toxic Emissions to gather data on the presence, control, and emission of potentially hazardous air pollutants (HAPs) at eight different coal-burning electric power stations representing a cross-section of the coals, boiler designs, and emissions control technologies in the United States. Southern Research Institute (SRI) was awarded a contract in April 1993 to assess two of the eight power stations in 1993, with an option to evaluate two more power stations in 1994. SRI conducted tests at the Springerville Generating Station of Tucson Electric Power Company, the Bailly Generating Station of Northern Indiana Public Service and the associated advanced scrubber system owned and operated by Pure Air, and the Blacksville No. 2 Coal Preparation Plant of CONSOL. Field sampling at the two coal-fired power plants was completed in 1993, and sampling at the coal preparation plant was completed in April 1994. This manuscript describes the results of the assessment at Springerville Generating Station. This station represents the configuration of NO_x reduction by combustion modification, SO_2 control with a dry scrubber, and particulate control with a baghouse. The test was conducted from June 1 through June 9, 1993.

4952 (CONF-940780–Vol.2, pp. 567-574) **An online optical monitoring of air toxics.** Bykovski, V.K. (Univ. of Massachusetts, Lowell, MA (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract FG02-93ER81534. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

New methods are needed to analyze and monitor multicomponent, for example, air toxic mixtures. The existing methods are basically a single-pass measurement and do not provide enough information. We propose an optical exploration approach, a multistep feedback controlled technique that includes multiple measurements with systematic modification of mixture to get additional data. We discuss various optical techniques to modify and probe air toxic mixtures. The data obtained from the multiple measurements allow the individual concentrations to be evaluated. Experimental data on the feasibility Phase I project are presented.

4953 (CONF-940780–Vol.2, pp. 575-578) **The behavior of CO_2 under simulated deep ocean conditions.** Cugini, A.V. (Department of Energy, Pittsburgh, PA (United States)); Warzinski, R.P.; Holder, G.D. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Anthropogenic emissions of CO_2 may adversely effect the environment in the not-too-distant future. If this occurs before nonfossil energy sources are developed, we may be forced to consider sequestering CO_2, especially that emitted by large point sources such as power plants. Ocean disposal of anthropogenic CO_2 emissions has the potential of sequestering CO_2 for time periods long enough to mitigate its anticipated buildup in the atmosphere over the next 200 years. The level of reduction depends on the relative amount released into the ocean and the depth of discharge. Effective sequestering of CO_2 in the ocean is expected if release depths are greater than 1000 m, which is also near the limit of current undersea piping technology. The behavior of CO_2 in water under conditions similar to those anticipated for deep-ocean disposal has been observed in a high-pressure, variable-volume view cell. A diagram of the view cell system is shown. Hydrate formation and dissolution have been observed to occur in this system according to published phase behavior data for this system. Observations of the relative density of CO_2 clathrate hydrates with respect to the CO_2-saturated water from which they were formed have also been made in the view cell. A mathematical model of the effect of hydrate formation on liquid CO_2 droplets is also being developed. Based upon this model, the path of hydrate-coated CO_2 droplets at various depths can be determined. Under certain conditions the formation of hydrates can result in particles dense enough to sink in the ocean. Most of the work in the literature that attempts to predict the fate of CO_2 droplets injected at various depths in the ocean does not incorporate hydrate formation into the models.

4954 (CONF-940780–Vol.2, pp. 631-638) **Particulate emission abatement for Krakow boiler houses.** Wysk, S.R. (LSR Technologies, Inc., Acton, MA (United States)); Surowka, J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Environmental clean-up and pollution control are considered foremost national priorities in Poland. More than four decades of centralized planning has produced serious contamination of air, water, and soil throughout the country and a resulting deterioration of public health. As a result, life expectancy is lower today than it was 20 years ago. Also, incidents of serious disease in adults and young children there have been on the rise. It is therefore, imperative that corrective action be taken. The government of Poland has begun to implement strong environmental controls to reverse this condition. The target of these controls is the Polish coal industry, which currently comprises over 78% of primary energy production (65% hard coal and 13% lignite). The coal utilization, especially in low grade coals, is highly inefficient. For example, Poland uses almost three times as much energy as Western Europe per unit of gross domestic product (GDP). In many cases, coal combustors have no pollution controls. Moreover, most have relatively low stacks and release emissions relatively close to the ground, further aggravating the problem. The result is that concentrations of airborne dust have been found to be many times higher than the maximum safe level. The City of Krakow, one of the world's great cultural centers, has a serious problem with airborne pollutants. These emissions are discharged from stacks burning coal, mainly unwashed. This paper discusses one of the projects initiated by the Department of Energy for environmental cleanup in Krakow. This particular project involves an efficient control technology for mitigation of particulate emissions. The technology is referred to as

the Core Separator, and it has been under development by LSR Technologies, Inc. in the USA.

4955 (TVA/RG/EQS–92-8) **Flue gas desulfurization gypsum and fly ash.** Tennessee Valley Authority, Knoxville, TN (United States). May 1992. 194p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003300. Source: OSTI; NTIS; INIS.

The Cumberland Fossil Plant (CUF) is located in Stewart County, Tennessee, and began commercial operation in 1972. This is the Tennessee Valley Authority's newest fossil (coal-burning) steam electric generating plant. Under current operating conditions, the plant burns approximately seven million tons of coal annually. By-products from the combustion of coal are fly ash, approximately 428,000 tons annually, and bottom ash, approximately 115,000 tons annually. Based on historical load and projected ash production rates, a study was initially undertaken to identify feasible alternatives for marketing, utilization and disposal of ash by-products. The preferred alternative to ensure that facilities are planned for all by-products which will potentially be generated at CUF is to plan facilities to handle wet FGD gypsum and dry fly ash. A number of different sites were evaluated for their suitability for development as FGD gypsum and ash storage facilities. LAW Engineering was contracted to conduct onsite explorations of sites to develop information on the general mature of subsurface soil, rock and groundwater conditions in the site areas. Surveys were also conducted on each site to assess the presence of endangered and threatened species, wetlands and floodplains, archaeological and cultural resources, prime farmland and other site characteristics which must be considered from an environmental perspective.

4956 (VTT-TIED–1559) **Greenhouse impacts of the use of peat and wood for energy.** Savolainen, I. (VTT Energy, Espoo (Finland). Energy and Power Systems); Hillebrand, K.; Nousiainen, I.; Sinisalo, J. Technical Research Centre of Finland, Espoo (Finland). 1994. 77p. Order Number DE95723874. Source: OSTI; NTIS; INIS.

Atmospheric concentrations of greenhouse gases may well double or increase even more during the next hundred years. The resultant disturbance in the global radiation energy balance (radiative forcing) may change almost as much. Stabilizing these concentrations at a level innocuous to the climate - the aim expressed in the Climate Convention - will take decades, perhaps more than a hundred years, to carry out. This study examines the greenhouse impacts of using peat and wood for energy and the time factors involved, taking the entire energy production chain and renewal of the energy source into account. The greenhouse effects of peat and wood use are compared with those of fossil fuels. The calculations apply to test cases. Financial considerations and other sources of energy are not dealt with. Greenhouse effects are measured in terms of radiative forcing caused by using an energy resource. The calculations are made per units of primary energy. The study further proposes ways to apply the results obtained to assessing the extent to which radiative forcing caused by Finland could be reduced by the use of peat or wood fuels. The calculations take into account emissions of CO_2, CH_4, $N2_O$ and possible sinks of CO_2 arising from energy production. The emissions and sinks of each chain of energy production are calculated as a function of time, deducting emissions which would arise in the reference case, in which energy production is not begun. Heal emissions due to production are obtained by deducting emissions in the reference case from emissions which arise during production. The difference is used as a basis for calculating radiative forcing per unit of energy produced

0120 Mining

Refer also to citation(s) 4956, 5030, 5043

4957 (DOE/METC–94/1002, pp. 443-444) **Evaluation and optimization of vertical gob gas ventilation wells.** Mavor, M.J. (Resource Enterprises Inc., Salt Lake City, UT (United States)); Robinson, J.R.; Marshall, R.B. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FG03-92ER81442. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

A gob well was completed and instrumented to independently monitor total gas and methane production and associated surface producing pressures from a mined out coal seam and the overlying strata. The purpose of the project was to collect sufficient data from which to estimate the properties and volume of the gob region contributing to flow. The test gob well was the 190 C located above B seam in the 9 Left D East Longwall panel of the Cambria 33 Mine. The Cambria 33 Mine is operated by BethEnergy Mines Inc. and is located in Cambria County, Pennsylvania. Data was collected prior to the mine face reaching the location of the test well, during the mine through, and for approximately two weeks after mine through. The project was successfully completed as sufficient data was collected to evaluate the gob region properties and the drainage volume of the well. Evaluation of the vertical well performance with a coal gas reservoir simulator suggested that the 190 C well was draining gas from a thirteen foot thick, 7.5 acre drainage area. The mined coal volume is contained within a 700 by 4,200 foot area corresponding to 67.5 acres. This comparison suggests that 9 vertical wells may be sufficient to control gas emissions into the workings if the productivity of the vertical wells can be maintained. Gas emissions in this panel were controlled with fourteen vertical wells and six boreholes. A significant potential exists for reduction of the degasification cost.

4958 (DOE/PC/92578–T3) **Capsule Pipeline Research Center. 3-year Progress report, September 1, 1993–August 31, 1994.** Missouri Univ., Columbia, MO (United States). Capsule Pipeline Research Center. 1 Apr 1994. 191p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93PC92578. Order Number DE95003559. Source: OSTI; NTIS; INIS; GPO Dep.

The Capsule Pipeline Research Center is devoted to performing research in capsule pipelines so that this emerging technology can be developed for early use to transport solids including coal, grain, other agricultural products, solid wastes, etc. Important research findings and accomplishments during the first-three years include: success in making durable binderless coal logs by compaction, success in underwater extrusion of binderless coal logs, success in compacting and extruding coal logs with less than 3% hydrophobic binder at room temperature, improvement in the injection system and the pump-bypass scheme, advancement in the state-of-the-art of predicting the energy loss (pressure drop) along both stationary and moving capsules, demonstrated the effectiveness of using polymer for drag reduction in CLP, demonstrated the influence of zeta potential on coal log fabrication, improved understanding of the water absorption properties of coal logs, better understanding of the mechanism of coal log abrasion (wear), completed a detailed economic evaluation of the CLP technology and compared coal transportation cost by CLP to that by rail, truck and slurry pipelines, and completion of several areas of legal research. The Center also conducted important technology transfer activities including workshops, work sessions, company seminars, involvement of companies in CLP research, issuance of newsletters, completion of a video tape on CLP, and presentation of research findings at numerous national and international meetings.

4959 (ETDE/DE-mf–95725527) **Automation in mining. Autonomous intrinsically safe image processing system. Underground testing. Final report.** Dahlhaus, N. Ruhrkohle Bergbau AG, Herne (Germany). Aug 1994. 56p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0328902F. Order Number DE95725527. Source: OSTI; NTIS (US Sales Only).

Great endeavours are made for rationalisation by introduction of novel automation technologies. Automatic cycles or any other methods, however, can only be designed on basis of reliably working sensors. Within this research and development project an autonomous intrinsically safe image processing system was designed, developed, and tested for: - Underground use on various operation sites as optical monitoring system - Reliably gathering and analysing operational status parameters - Responding by

control signal according to the identified operational status. As example it was demonstrated that the underground image processing system can monitor conveyor belts and transfer points for belt runout, damages to the beld edges, overload, and foreign matters on the belt. In addition, operation data, such as the conveyed bulk volume as well as idle time and downtime, are logged. The test on the conveyor belt test rig as well as underground have shown that the system performs well and reliably. Operation was almost trouble-free. In its present configuration the system is not designed for manriding according to safety rules, however, safe manriding could be catered for. The use of the image processing system means less stress to the staff of the colliery control center since there is no need anymore for steady watching corresponding video monitors. (orig.)

4960 (ETDE/DE-mf–95733415) **FSV technology for passenger, materials and coarse debris transport in the main roadway network of the Haard satellite mine. Final report.** Einhaeuser, J. Ruhrkohle AG, Essen (Germany). Sep 1992. 98p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0322056B; Contract RAG 04860100. Order Number DE95733415. Source: OSTI; NTIS (US Sales Only).

A free-steered transport system was developed which can be used for passenger, materials and, with restrictions, debris transport around the shaft (distance max. 4 km). The system includes all-wheel driven or center pivot steered passenger busses with max. 26 seats, a combination of trucks with trailers (20 t payload) and material transporters (5 and 8 t) as well as special vehicles for heavy loads of up to 14 t (shield supports) and loaders (4 and 6 t) for dinting, loading and transport work. The vehicles can be used in roadways with free cross sections of more than 3 m width and 2.4 m height and inclinations of up to 1 in 4. For inclinations of more than 1 in 10 the transport velocity is insufficient (with the exception of the loaders) because suitable Diesel engines are currently not available for the vehicles. The applicability of the vehicles is mainly determined by the condition of the lanes or roadways. Suitable lane construction methods were developed. An EDP assisted transport simulation model is available for the planning work. (orig.)

4961 (ETDE/DE-mf–95733473) **Reduction of hazard and strain when developing inclined faces. Final report.** Groebel, K. Ruhrkohle AG, Essen (Germany). Jul 1992. 38p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 01HD037A. Order Number DE95733473. Source: OSTI; NTIS (US Sales Only).

The conventional installation of shield supports in faces to be developed and the alignment and positioning of the shields represents a considerable physical strain for and hazard to the workers employed. Therefore, a slewing and positioning device was developed which is used to transload the shield supports in the face from the transport facility, to turn them into direction of face advance and to position them. The slewing and positioning device includes the actual slewing facility and two pusher frames at both sides serving as abutments for the slewing facility. The overall advice is advanced by using these frames. The device was tested in use at Walsum colliery in the Robert seam under extremely difficult conditions with a seam inclination of 42 gon and a lateral inclination of 8 gon for a seam thickness of up to 3.1 m. Although a significant performance increase compared to the conventional installation of the shields could not be achieved when testing the slewing and positioning device, the project's objective could nevertheless be reached completely because - not a single accident occurred during the total installation, - the strain reduction could be proven in a preceding R and D project and - the device is regarded as advantageous by the manpower. (orig.). 7 figs.

0130 Transport, Handling, and Storage

4962 (CONF-940780–Vol.1, pp. 35-39) **Improvement of storage, handling, and transportability of fine coal.** Davis, B.E. (Energy International Corp., Pittsburgh, PA (United States)); Maxwell, R.C.; Jamison, P.R. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

Fine coal production is on the rise in the U.S., and it will continue to increase as underground mining companies invest in more productive equipment. Fine coal cleaning technologies have been developed which can efficiently and economically separate coal from clay and other mineral matter in the fine size fractions, but they have not gained universal acceptance in the coal industry because they produce a product which is too wet for acceptance in the market place. Historically coal producers take one of two approaches in dealing with fine coal production. On the one hand, they may wash it and recover it as a wet cake which must be thermally dried prior to shipment. On the other hand, many operators make no attempt to recover fine coal, and dispose of it as a wet cake or slurry in refuse piles, slurry impoundments and abandoned deep mines. There are environmental problems related to both of these practices.

4963 (SAND–94-2732) **Meeting on flows of granular materials in complex geometries.** Passman, S.L.; Fukushima, E.; Evans, R.E. (eds.). Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 94p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9408197–: Flows of granular materials in complex geometries meeting, Albuquerque, NM (United States), 15-16 Aug 1994). Order Number DE95004822. Source: OSTI; NTIS; GPO Dep.

The International Energy Agency Fossil Fuel Multiphase Flow Sciences Agreement has been in effect since 1986. The traditional mechanism for the effort has been information exchange, effected by the inclusion of scientists in annual Executive committee meetings, by exchange of reports and papers, and by visits of scientists to one another's institutions. In a sequence of informal meetings and at the 1993 Executive committee meeting, held in Pittsburgh, US in March 1994, it was decided that more intensive interactions could be productive. A candidate for such interactions would be specific projects. Each of these would be initiated through a meeting of scientists in which feasibility of the particular project was decided, followed by relatively intense international co-operation in which the work would be done. This is a report of the first of these meetings. Official or unofficial representatives from Canada, italy, japan, mexico, the United Kingdom, and the US met in Albuquerque, New Mexico, US, to consider the subject Flows of Granular Materials in Complex Geometries. Representatives of several other countries expressed interest but were unable to attend this meeting. Sixteen lectures were given on aspects of this topic. It was decided that a co-operative effort was desirable and possible. The most likely candidate for the area of study would be flows in bins and hoppers. Each of the countries wishing to co-operate will pursue funding for its effort. This report contains extended abstracts of the sixteen presentations and a transcription of the final discussion.

0140 Combustion

Refer also to citation(s) 4904, 4956, 5650, 5653, 5656, 5657, 5658, 5662, 5663, 5664, 5667, 5680, 5688, 5692, 6072, 6090, 7051

4964 (CONF-940780–Vol.2, pp. 387-394) **Kinetics and mechanisms of coal char combustion and carbon burnout.** Hurt, R.H. (Sandia National Labs., Livermore, CA (United States)); Davis, K.A.; Yang, N.Y.C.; Hardesty, D.R. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The amount of unburned carbon fly ash is an important concern in the design and operation of pulverized coal fired boilers, affecting combustion efficiency, boiler performance, and ash marketability. The late stages of char combustion have a special technological significance, as carbon conversions of 99% or greater are typically

required for the economic operation of commercial-scale systems. Achieving such high conversions is difficult in certain cases, especially in connection with boilers retrofitted with combustion zone modifications for NO_x abatement. While there is an extensive literature on ignition, and char combustion, there have been many fewer studies of extinction, conversion-dependent reactivities, or the important late stages of combustion, in part due to the difficulty of making scientifically meaningful measurements on highly reacted samples in which inorganic material (ash) is the majority constituent. In Sandia's Coal Combustion Laboratory (CCL), unique optical techniques and advanced materials analytical facilitates are developed and used to determine char oxidation kinetics with an emphasis on the late stages of combustion. Experiments are performed on a suite of commercially-important US coals of various rank and type, as well as residual carbon materials extracted from fly ash samples from commercial-scale coal combustors. The ultimate goal of the project is the development of an advanced, time-dependent kinetic model that predicts the combustion rates and burnout times of chars over a wide range of conditions of interest to current and future pulverized coal combustion technologies.

4965 (CONF-940780--Vol.2, pp. 413-420) **Fundamental study of ash formation and deposition: Effect of reducing stoichiometry.** Helble, J.J.; Bool, L.E.; Kang, S.G.; Moniz, G.A.; Sarofim, A.F.; Zeng, T.; Peterson, T.W.; Gallien, D.; Huffman, G.P.; Shah, N. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

This project is designed to examine the effects of combustion stoichiometry on the fundamental aspects of ash formation and ash deposit initiation. Emphasis is being placed on reducing stoichiometries associated with low-NOx combustion, although a range of oxidant/fuel ratios are being considered. Previous work has demonstrated that ash formation depends strongly upon coal mineralogy, including mineral type, size, amount, and the presence of organically associated inorganic species. Combustion temperature and the oxidation state of iron also play a significant role. As these latter items will vary with changes in stoichiometry, research to determine the net effect on deposition is required.

4966 (CONF-940780--Vol.2, pp. 441-448) **Krakow clean fossil fuels and energy efficiency project.** Pierce, B.L. (Brookhaven National Lab., Upton, NY (United States)); Butcher, T.A. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Almost half of the energy used for heating in Krakow is supplied by low-efficiency boilerhouses and home coal stoves. Within the town, there are more than 1,300 boilerhouses with a total capacity of 1,071 MW, and about 100,000 home furnaces with a total capacity of about 300 MW. More than 600 boilerhouses and 60 percent of the home furnaces are situated near the city center. These facilities are referred to as "low emission sources" because they have low stacks. They are the primary sources of particulates and hydrocarbons in the city, and major contributors of sulfur dioxide and carbon monoxide. The Support for Eastern European Democracy (SEED) Act of 1989 directed the US Department of Energy (DOE) to undertake an equipment assessment project aimed at developing the capability within Poland to manufacture or modify industrial-scale combustion equipment to utilize fossil fuels cleanly. This project is being implemented in Krakow as the "Krakow Clean Fossil Fuels and Energy Efficiency Project." Funding is provided through the US Agency for International Development (AID). The project is being conducted in a manner that can be generalized to all of Poland and to the rest of Eastern Europe.

4967 (CONF-940780--Vol.2, pp. 449-456) **A coal-fired combustion system for industrial process heating applications.** Hnat, J.G. (Vortec Corp., Collegeville, PA (United States)); Myles, P.T.; Jian, C.Q. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-91PC91161. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

This advanced combustion system research program is for the development of innovative coal-fired process heaters which can be used for high temperature melting, smelting, recycling, and refining processes. These process heaters are based on advanced glass melting, waste vitrification, and ore smelting furnaces developed and patented by Vortec Corporation. The process heater systems have multiple use applications; however, the Phase III research effort is being focused on the development of a process heater system to be used for the vitrification of waste ashes. In many cases, the vitrified glass product can be used for the production of value added products such as mineral wood. The Vortec CMS represents a significant advancement in glass melting/vitrification technology. This suspension melting process can be used for a variety of high temperature process heating applications. The primary components of the CMS are a counter-rotating suspension preheater and a cyclone melter. An artist rendering of the basic CMS concept is shown.

4968 (CONF-940780--Vol.2, pp. 457-465) **Development and testing of an industrial scale, coal fired slagging combustion system.** Zauderer, B. (Coal Tech Corp., Merion Station, PA (United States)); Fleming, E.S.; Borck, B. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-91PC91162. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The primary objective of the present effort is to perform extended duration testing of a 20 MMBtu/hr commercial scale, air cooled, slagging coal combustor. Combustor applications include coal and solid fuel combustion in industrial steam boilers and power plants. The tests focus on durability and automatic control of the combustor. Another goal is to achieve 0.4 lb/MMBtu of SO_2 emissions, 0.2 lb/MMBtu of NO_x emissions and 0.02 lb particulates/MMBtu in the combustor boiler system. The average NO_x level for all test conditions to date was 0.5 lb/MMBtu at a combustor stoichiometric ratio of 0.75. At optimum staged combustion conditions, the lowest NO_x level measured was 0.26 lb/MMBtu. With sorbent injection into the combustor at an effective Ca/S mol ratio of 3, the average SO_2 level at the boiler outlet was 0.7 lb/MMBtu, equal to a 70% reduction in 1.7% sulfur coals. The maximum reduction achieved was about 85%, equal to 0.36 lb/MMBtu in a 1.5% sulfur coal. Separately, SO_2 levels of 0.6 lb/MMBtu, equal to 81% reduction in a 2% sulfur coal was measured with only boiler injection of the sorbent. Therefore, a combination of sorbent injection inside the combustor and inside the boiler should meet the project goal for SO_2.

4969 (CONF-940780--Vol.2, pp. 467-474) **Development and testing of a high efficiency advanced coal combustor: Industrial boiler retrofit.** Jennings, P.L. (ABB Power Plant Labs., Windsor, CT (United States)); Borio, R.W.; Miller, B.G.; Scaroni, A.W.; McGowan, J.G. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Under US Department of Energy, Pittsburgh Energy Technology Center (PETC) support, the development of a High Efficiency Advanced Coal Combustor (HEACC) has been in progress since 1987 at the ABB Power Plant Laboratories. As summarized in previous publications on the subject, the initial work produced an advanced coal firing system that was capable of firing both water-based and dry pulverized coal in an industrial boiler environment.

With continued DOE-PETC support, carried out in cooperation with the Energy and Fuels Research Center of the Pennsylvania State University (Penn State), the HEACC burner concept has been used as a major component in a system design intended for industrial-scale, coal fired retrofit applications. The overall objective of the current work is to demonstrate the technical and economic feasibility of retrofitting a gas/oil-designed industrial boiler to burn micronized coal. In this respect, the major technical goals for the combustion system design have included: A compact, easy to retrofit burner design; Low NOx generation, while maintaining high combustion efficiency; Commercially acceptable combustion air pressure drop and burner turndown ratio; and Integration of coal preparation system controls into boiler control system.

4970 (CONF-940780–Vol.2, pp. 479-486) **Development of a coal water slurry-fired commercial scale space heating system.** Litka, A.F. (Thermo Power Corp., Waltham, MA (United States)); Breault, R.W. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Coal is the most plentiful energy resource in the United States today, but since the 1950's, its use has been largely restricted, for environmental and economic reasons, to utility power generation. Oil and natural gas are the predominant fuels used within the residential, commercial, and industrial market sectors. The objective of this program is to demonstrate the technical and economic viability of a coal-fired combustion system capable of meeting the space heating needs of schools, office buildings, apartment complexes, and other similar structures which make up the commercial market sector. In general, these buildings require firing rates of 1 to 10 million Btu/hr. An important consideration in meeting this objective is the fuel form to be utilized. In attempting to restore coal to relatively small markets, it is important to recognize ease of handling and storage as important criteria. For this reason, coal water slurry fuel has been chosen as the fuel form for this development effort. Coal water slurry eliminates the need to use dry pulverized coal with its attendant handling, metering, and dusting problems, as well as its explosive potential. Equally important in selecting a fuel form is the impact on emission levels and pollution control equipment requirements. Coal water slurry (CWS) is amenable to coal washing, since coal cleaning technologies are generally water-based processes requiring fine grinding of the coal.

4971 (CONF-940780–Vol.2, pp. 487-495) **Condensing economizers for small coal-fired equipment.** Butcher, T.A. (Brookhaven National Lab., Upton, NY (United States)); Litzke, W. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC02-76CH00016. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Condensing economizers can be used to increase the thermal efficiency of boilers and furnaces. This study focuses on evaluating indirect contact economizers as applied to heating equipment burning coal-water mixtures although the results can be extended to other fuels. In addition to dry gas sensible heat, latent heat is recovered from flue gas water vapor, improving system efficiency markedly. In addition to improving thermal efficiency, condensing economizers can also capture particulates. In tests to date up to 98% total removal has been measured. The primary objectives of this project are to evaluate the most important mechanisms involved in particle capture and to enhance capture in practical systems.

4972 (CONF-940780–Vol.2, pp. 499-506) **Engineering design considerations of industrial boilers retrofits.** Morrison, D.K. (Energy and Environmental Research Corp., Orrville, OH (United States)); Frato, R.L. Jr.; Melick, T.A.; Sommer, T.M.; Miller, B.G.; Scaroni, A.W. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract FC22-92PC92162. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The Energy and Environmental Research Corporation (EER) and the Pennsylvania State University are engineering the conversion of an existing heavy fuel oil and natural gas-fired watertube boiler at a US Department of Defense (DOD) facility to fire either micronized coal-water slurry fuel (MCWSF) or dry, micronized coal (DMC). The host boiler is located in building No. 150 at the Crane Naval Surface Weapons Center in Crane, Indiana. The retrofit is being conducted as part of a program for DOD and the US Department of Energy in which coal-based technologies are being evaluated to determine the technical and economic viability of replacing heavy fuel oil with coal in industrial-sized boilers. Retrofit options currently being evaluated are the direct firing of MCWSF and DMC, and coal precombustion technologies. The status of the evaluations and designs of the MCWSF and DMC direct firing technologies is presented.

4973 (CONF-940780–Vol.2, pp. 507-516) **Combustion characterization of beneficiated coal-based fuels.** Chow, O.K.; Hargrove, M.J.; Levasseur, A.A. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-89PC88654. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The Pittsburgh Energy Technology Center (PETC) of the US Department of Energy is sponsoring the development of advanced coal-cleaning technologies aimed at expanding the use of the nation's vast coal reserves in an environmentally and economically acceptable manner. Because of the lack of practical experience with deeply beneficiated coal-based fuels, PETC has contracted Combustion Engineering, Inc. to perform a multi-year project on "Combustion Characterization of Beneficiated Coal-Based Fuels." The objectives of this project include: (1) the development of an engineering data base which will provide detailed information on the properties of Beneficiated Coal-Based Fuels (BCFs) influencing combustion, ash deposition, ash erosion, particulate collection, and emissions; and (2) the application of this technical data base to predict the performance and economic impacts of firing the BCFs in various commercial boiler designs.

4974 (CONF-940780–Vol.2, pp. 517-524) **Utilization of coal-water fuels in fire-tube boilers.** Morrison, D.K. (Energy and Environmental Research Corp., Orrville, OH (United States)); Melick, T.A.; Sommer, T.M. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-90PC90165. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The Energy and Environmental Research Corporation (EER), in cooperation with the University of Alabama and Jim Walter Resources, was awarded a DOE contract to retrofit an existing fire-tube boiler with a coal-water slurry (CWS) firing system. Recognizing that combustion efficiency was the principle concern when firing slurry in fire-tube boilers, EER focused the program on innovative approaches for improving carbon burnout without major modifications to the boiler. The project was completed in April 1994. The boiler was successfully operated on coal-water slurry for 800 hours. A boiler derate of 20 percent was necessary for successful operation with slurry accounting for 62 percent of the total heat input with the balance provided by natural gas. Under these boiler conditions, the carbon conversion was 90 percent. The economics of slurry firing in fire-tube boilers is also presented in this paper.

4975 (CONF-940780–Vol.2, pp. 525-532) **Development of the integrated environmental control model: Update on project status.** Rubin, E.S. (Carnegie Mellon Univ., Pittsburgh, PA (United

States)); Berkenpas, M.B.; Kalagnanam, J.R.; Frey, H.C. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

This paper describes the Integrated Environmental Control Model (IECM), an analytical model developed for the US Department of Energy's Pittsburgh Energy Technology Center (DOE/PETC). Model development work is continuing under a new contract initiated in October 1992. The model quantifies the performance and cost of power plant designs that involve user-specified combinations of pre-combustion, combustion, and post-combustion methods of environmental control. A unique feature of the IECM is the ability to characterize uncertainty in probabilistic terms, in contrast to conventional deterministic analysis. This capability offers special advantages in analyzing advanced technologies at an early stage of development, and in comparing them with conventional systems where uncertainties typically are smaller. This paper reviews the current status of model development and plans for further refinements, testing and applications.

4976 (CONF-940780–Vol.2, pp. 659-667) **Micronized coal firing applied to plants in the Czech Republic and Krakow, Poland.** Sheahan, R. (TCS, Inc., Oakland, MD (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

A TCS Micronized Coal-Fired System offers the Czech Republic and Poland a unique opportunity to retrofit its existing industrial, utility and district heating plants and achieve increased combustion efficiencies coupled with reduced air emissions. Micronized coal is coal ground to a micron-size "talcum powder" consistency; which, because of its extremely fine particle size, has unique characteristics affecting combustion efficiency, reduction of sulfur dioxide and nitrogen oxide air emissions and the potential for producing by-product markets for its resulting ash.

4977 (CONF-940780–Vol.2, pp. 669-677) **Combustion improvements in stoker fired boilers.** Myers, J.R. (Pennsylvania State Univ., University Park, PA (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Stoker fired boiler plants are common throughout Eastern Europe. The small and mid-sized coal combustion plants utilize travelling grate stokers to produce steam or hot water that is used by district heating companies and industries. When these plants were first designed 25 to 50 years ago, reliability was the key concern. Now, the 1990's, there is considerable attention being paid to increasing efficiency and reducing emissions.

4978 (CONF-940780–Vol.2, pp. 687-694) **Status report on the development of a low NO_x combustor.** Moussa, N.A. (Blazetech Corp., Winchester, MA (United States)); Surks, P.J.; Rogers, C.B. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

This paper presents a progress report on an innovative, proprietary combustor design for nitric oxides (NO_x) reduction from coal combustion. Pre-mixed natural gas is co-fired in an opposed flow configuration to the coal/primary air stream. Thus, intense mixing is produced and coal is devolatilized in an oxygen poor environment to minimize fuel NO_x. The products of devolatilization are then burned with secondary air in a conventional manner. Cold flow tests were conducted on a small scale model using opposed water jets. Laser Induced Fluorescence and LDV measurements were carried out for flow visualization and characterization. Mixing increased significantly with increasing momentum ratio of the opposed jets. Drawing upon these results, a scaled-up combustor was built and tested at the Riley Stoker 3 million BTU/hr Pilot Scale Combustion Facility. Three days of tests showed that using natural gas firing at a small percentage of coal firing can consistently reduce NO_x emissions, without adverse effects on furnace emission or thermal performance. In fact, coal flame stability was improved at low load. Problems were encountered, but they appear very tractable.

4979 (DOE/MC/27229–3948) **Pulsed atmospheric fluidized bed combustion. Technical progress report, July 1994–September 1994.** Thermochem, Inc., Columbia, MD (United States). 30 Nov 1994. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-90MC27229. Order Number DE95004303. Source: OSTI; NTIS; GPO Dep.

No changes in the process design were encountered during this period. Minor modifications in the combustor vessel and pulse combustor water jacket were made for ease of operation and maintenance. The combustor vessel column location in the foundation was rotated to 90 degrees to accomodate change in bed module orientation. Landings for the platform staircase were added in the structural drawings. Design and drawings for embedded conduits and grounding system were completed.

4980 (DOE/MC/29264–3933) **Scaling of pressurized fluidized beds: Quarterly report, July–September 1994.** Massachusetts Inst. of Tech., Cambridge, MA (United States). Oct 1994. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-92MC29264. Order Number DE95000026. Source: OSTI; NTIS; GPO Dep.

Laboratory-scale cold fluidized beds have been used extensively to study fluidized-bed hydrodynamics. Cold models have the advantage that they permit detailed room temperature investigations, such as determining the effects of varying operating parameters and bed design on the hydrodynamics, to be performed in a rapid and cost-effective manner. However, in order for the results of these investigations to be relevant to commercial fluidized bed combustors, the cold model must be properly scaled to simulate hot-bed hydrodynamics. Previously, it has been shown that laboratory-scale cold models can be used to simulate the hydrodynamics of a hot fluidized bed combustor when a set of dimensionless scaling laws is matched between the two beds. These scaling laws have been verified by numerous researchers in both atmospheric bubbling and circulating fluidized beds. A recent study at MIT, on atmospheric circulating beds, demonstrated that it was possible to relax some of the scaling relationships, producing a simplified set of scaling laws which allows the model to be much smaller than the combustor. In the current study, the simplified scaling laws are applied to pressurized bubbling fluidized beds. A quarter-scale cold model of American Electric Power's (AEP) Tidd 70 MW_e pressurized fluidized bed combustor (PFBC) has been constructed. The scale model has been used to establish the validity of the simplified scaling laws for pressurized bubbling beds. Scaling verifications include comparisons of the probability density functions of the pressure fluctuations in the Tidd PFBC and the cold model. A comparison of the average solid-fraction profiles is also presented.

4981 (DOE/METC–94/1008-Vol.2, pp. 519-534) **Tidd PFBC hot gas filter operating experience: July 1993 - April 1994.** Hoffman, J.D. (Ohio Power Co., Columbus, OH (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FC21-89MC26042. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objective of this program is to evaluate the design and obtain operating experience for up to two Advanced Particle Filter

(APF) systems through long-term testing on a slipstream at Ohio Power Company's Tidd Pressurized Fluidized Bed Combustion (PFBC) Demonstration Plant. Performance and reliability of commercial-scale filter modules will be monitored to aid in an assessment of the readiness and economic viability of this technology for commercial PFBC applications.

4982 (DOE/METC–94/1008-Vol.2, pp. 535-544) **Karhula hot gas cleanup test results.** Bruck, G.J. (Westinghouse Electric Corp., Pittsburgh, PA (United States)); Isaksson, J. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FC21-89MC26042. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objective of this work is to develop a practical hot gas filter design that meets the performance and operational requirements of pressurized fluidized bed combustion - bubbling bed, circulating bed and second generation - applications. The Westinghouse hot gas candle filter system is currently installed in the Ahlstrom Pyropower 10 MW (thermal) pressurized circulating fluidized bed combustor (PCFB) test facility located in Karhula, Finland. The overall objective of the testing is to evaluate the filter design and operating reliability for selection and implementation into the Midwest Power DMEC-1 PCFB 150 MW_e repowering project (Clean Coal III Selection).

4983 (DOE/METC–94/1008-Vol.2, pp. 545-571) **Durability of ceramic filters.** Alvin, M.A. (Westinghouse Electric Corp., Pittsburgh, PA (United States)); Lippert, T.E.; Diaz, E.S.; Smeltzer, E.E.; Tressler, R.E. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FC21-89MC26042 ; AC21-86MC23252. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of this program are to identify the potential long-term thermal/chemical effects that advanced coal-based power generating systems have on the stability of porous ceramic filter materials, as well as to assess the influence of these effects on filter operating performance and life.

4984 (DOE/PC/89659–T15) **Coal reburning for cyclone boiler NO_x control demonstration. Quarterly report No. 14, July–September 1993.** Haggard, R.W. Jr. Babcock and Wilcox Co., Cassville, WI (United States). 22 Oct 1993. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89659. Order Number DE94009024. Source: OSTI; NTIS; GPO Dep.

The Coal Reburning for Cyclone Boiler NO_x Control Demonstration project progress for July, August and September 1993 is identified in this 14th quarterly report and pertains to the activities on draft Final Report Preparation. The project involves retrofitting/testing the reburning technology at Wisconsin Power & Light's 100 MW, Nelson Dewey Unit #2 in Cassville, Wisconsin to determine the commercial applicability of this technology to reduce NO_x emission levels. Phase III - Operation and Disposition activities emphasized preparation of the final report. A draft has been completed and it was provided to DOE/PETC in September for review and comment. The preliminary results of the hazardous air pollutant (HAP) testing indicate no major impact of reburn on volatile organics emissions. HAP results were completed and reported by Acurex in July, 1993.

4985 (DOE/PC/91292–T12) **Rheological properties essential for the atomization of coal water slurries (CWS). Quarterly progress report, June 15, 1994–September 1994.** Ohene, F. Grambling State Univ., LA (United States). Dept. of Chemistry. [1994]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91292. Order Number DE95003565. Source: OSTI; NTIS; GPO Dep.

The overall objective of this project is to perform experiments to understand the effect of high shear and extensional properties on the atomization of coal-water slurries (CWS). In the atomization studies, the mean drop size of the CWS sprays will be determined at various air-to CWS. A correlation between the extensional and high shear properties, particle size distributions and the atomization will be made in order to determine the influence of these parameters on the atomization of CWS. During the past quarter, further rheological testing of the CWS were performed. The measurements included oscillatory and low shear viscosity measurements. Prior to performing the oscillatory measurements, the oscillatory measurements of several concentrations of xantham gum solutions were made and the variation in the storage modulus and loss modulus noted. The data indicate that the storage modulus at a given frequency tend to increase with the concentration of the xantham gum. Oscillatory measurements were made on PSOC-1472 from Lower Banner. The results indicate that in this particular slurry, the degree of aggregation of the coal particles decrease as the coal content decreases. Also, during this past quarter, experimental studies on pressure dependent atomization of coal-water slurries and simulated fluids were continued. Surface tension, high and low shear flow behavior of the slurries were also performed.

4986 (DOE/PC/91297–T6) **A computational model for coal transport and combustion. Quarterly technical progress report, March 1, 1994–May 31, 1994.** Ahmadi, G. Clarkson Univ., Potsdam, NY (United States). Dept. of Mechanical and Aeronautical Engineering. [1994]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-91PC91297. Order Number DE94017554. Source: OSTI; NTIS; GPO Dep.

In the period of March 1, 1994 to May 31, 1994, the earlier developed computational models for analyzing flow of granular materials in ducts and passages with bumpy walls were used to analyze Couette and chute flows. The results were compared with the experimental data and good agreement was observed. Further results on the flows of gas-solid mixtures in vertical ducts were obtained. A computational model for analyzing two-phase flow was developed, and the phasic mean velocity and fluctuation energy profiles were evaluated. The results were compared with the experimental data of Tsuji an co-worker and good agreement was obtained. Further progress in the experimental study of mono-granular layer simple shear flow device was made. The experimental data concerning the mean granular velocity, fluctuation velocity and solid volume fraction were obtained. The resulting data revealed the importance of fluctuation energy components on dynamics of particulate flows.

4987 (DOE/PC/92190–T5) **Fundamental study of ash formation and deposition: Effect of reducing stoichiometry. Quarterly report No. 5, April 1, 1994–June 30, 1994.** Helble, J.J.; Bool, L.E.; Huffman, G.P.; Huggins, F.E.; Shah, N.; Peterson, T.W.; Gallien, D.; Reschke, R.; Sarofim, A.F.; Zeng, Taofang. PSI Technology Co., Andover, MA (United States). Aug 1994. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92190. (PSI–1178-94-2). Order Number DE95004321. Source: OSTI; NTIS; GPO Dep.

The technical objectives of this project are threefold. The first objective is to identify the partitioning of inorganic coal constituents among vapor, submicron fume, and fly ash products generated during combustion of pulverized coal under a variety of combustion conditions. Fuel rich and fuel lean conditions will be considered. The second objective is to identify and quantify the fundamental processes by which the transformation of minerals and organically-associated inorganic species occur. Emphasis will be placed on identifying any changes that occur as a result of combustion under sub-stoichiometric combustion conditions. The third objective is to incorporate the effects of combustion stoichiometry into an Engineering Model for Ash Formation based upon the understanding developed in pursuit of the first two objectives. When completed, this model will predict the particle size and chemical composition of pulverized coal under a broad range of conditions.

4988 (DOE/PC/94205–T1) **Mechanisms of pyrite oxidation to non-slagging species. Quarterly report, September 1–September 30, 1994.** Akan-Etuk, A.E.J.; Mitchell, R.E. Stanford Univ., CA (United States). High Temperature Gasdynamics Lab. Oct 1994. 12p. Sponsored by USDOE, Washington, DC (United

States). DOE Contract FG22-94PC94205. Order Number DE95003522. Source: OSTI; NTIS; GPO Dep.

This document is the first quarterly status report on a project concerned with enhancing the transformation of iron pyrite to non-slagging species during staged, low-NO_x pulverized coal (P.C.) combustion. The work focuses on the mechanistic description and rate quantification of the effects of fuel properties and combustion environment on the oxidation of iron pyrite to form the non-slagging species magnetite. The knowledge gained from this work is intended to be incorporated into numerical codes and used to formulate anti-slagging strategies involving minimal disturbance of coal combustor performance. The six tasks of the research program are: Production and characterization of pyrite feeds; Carbon matrix kinetics effects; Carbon matrix mass transfer effects; and Rate expression formulation and validation. In this report, the scope of the pyrite oxidation research project is defined. The activities associated with the six tasks of the research project are described.

4989 (NEDO-C–9324) **Next generation coal utilization technology. Pollutionless coal combustion technology (topping cycle).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 307p. (In Japanese). Order Number DE95723115. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

An investigational study is made on more high-efficient topping combustion as well as pressurized fluidized bed combustion, for the purpose of abating pollutant emission by improving efficiency of coal-fired boilers. As gasification furnace/oxidation furnace, the following are selected and designed: air-blown pressurized fluidized bed/pressurized fluidized bed (series type), oxygen-blown pressurized entrained bed/pressurized fluidized bed (parallel type), air-blown pressurized CPC (entrained bed)/pressurized pulverized coal combustion furnace (parallel type), and air-blown pressurized fluidized bed/pressurized fluidized bed (parallel type). Specs for trial design of the four systems are: generating end output; 294-425 MW, gas turbine/steam turbine output ratio; 49/51-60/40%, net thermal efficiency; 42-45%. Gas turbine inlet temperature; 1300°C range, steam; 246 kg/cm^2, 593°C max. In-furnace desulfurization is introduced to both gasification furnace and oxidation furnace. The trial design is to be made in fiscal 1993 and 1994. Besides, basic technical data and information are collected on pressurized circulating type fluidized bed boilers and topping combustion. 18 figs., 5 tabs.

4990 (NEDO-C–9325) **Next generation coal utilization technology. Coal combustion technology for environmental harmony (O2/CO2 combustion).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 292p. (In Japanese). Order Number DE95723112. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

For the global environmental preservation, the paper conducts an O2/CO2 combustion experiment on pulverized coal and studies an optimum O2/CO2 combustion technology system, for the purpose of developing a combustion system which minimizes pollutant emitted from coal-fired boilers. For basic research on CO2 recovery by oxygen combustion, carried out are dynamic simulation of the O2 generator, one-dimensional combustion simulation, O2/CO2 combustion tests and micro gravity combustion tests. When assuming amounts of raw material air and product oxygen to be disturbances, the O2 generator follows load fluctuations. In O2/CO2 combustion, less NOx is produced than in air combustion, that is, 60-70% NOx can be reduced as compared with air combustion because recycling NOx is reduced in the combustion field. SO2 also decreases, and most of the S content is found to be absorbed in the ash. In the micro gravity field, flames become dim and the flame propagation rate drops in the CO2 environment. The flame propagation rate becomes higher with increasing oxygen concentration. 4 refs., 185 figs., 25 tabs.

4991 (NEI-DK–1751) **SnO_2 sensors for measurement of combustion in industrial facilities and processes.** Jensen, H. PBI-Development A/S, Ringsted (Denmark). Oct 1994. 9p. (In Danish). Contract ENS-1223/89-11. Order Number DE95723850. Source: OSTI; NTIS.

EFP-89.

A preliminary investigation of a new type of ceramic semiconductor material based on doped tin oxide which could be used for sensors for measuring combustion in industrial facilities and processes is described. The sensors could be used for combustion control. This could lead to reduced energy consumption and a cleaner environment. It was concluded that the use of doped tin oxide as an active sensor material had considerable potential. A ceramic semiconductor material based on doped tin oxide can achieve an acceptable level of conductivity and a certain selectivity in connection with some gases which suggests the profitability of further investigation. (AB)

4992 (SAND–94-8761C) **Application of advanced technologies to ash-related problems in boilers.** Baxter, L.L. (Sandia National Labs., Livermore, CA (United States). Combustion Research Facility); Richards, G.; Harb, J. Sandia National Labs., Livermore, CA (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9408200–1: EPRI conference on the effect of coal quality on boiler performance, Charleston, SC (United States), 17-19 Aug 1994). Order Number DE95004379. Source: OSTI; NTIS; GPO Dep.

Prediction of ash behavior in boilers has, for many years, been based on relatively simple relationships involving the composition of inorganic material in fuels. In recent years, advanced analyses for both fuels and deposits have seen increasing use in the solid fuel combustion community. The combination of the standard and advanced analyses, together with a knowledge of boiler design and operating conditions, allow better interpretation of ash behavior in boilers than has previously been possible. This paper discusses several case histories where advanced technologies have been applied to interpret ash behavior in boilers where standard techniques were insufficient. Included in the discussion are: (1) the behavior of blends of fuels; (2) explanations for markedly different behavior between fuels with similar ASTM characteristics; and (3) effects of boiler operating conditions on ash deposit formation.

0150 Economic, Industrial, and Business Aspects

Refer also to citation(s) 5669, 5986, 6051, 6064

4993 (ANL/DIS/TM–18) **Coal use in the People's Republic of China. Volume 1: Environmental impacts.** Bhatti, N. (Argonne National Lab., IL (United States). Decision and Information Sciences Div.); Tompkins, M.M.; Carlson, J.L.; Simbeck, D.R. Argonne National Lab., IL (United States). Decision and Information Sciences Div. Nov 1994. 75p. DOE Contract W-31109-ENG-38. Order Number DE95004394. Source: OSTI; NTIS; INIS; GPO Dep.

The People's Republic of China (hereafter referred to as China) is the largest producer and consumer of coal in the world. Coal makes up 76% and 74% of China's primary energy consumption and production, respectively. This heavy dependence on coal has come at a high price for China, accounting for a large share of its environmental problems. This report examines the dominance of coal in China's energy balance, its impact on the environment, and the need for technical and financial assistance, specifically for two distinct aspects: the effect of coal use on the environment and the importance of coal to China's economy. The results of the analysis are presented in two volumes. Volume 1 focuses on full fuel cycle coal emissions and the environmental effects of coal consumption. Volume 2 provides a detailed analysis by sector of China's economy and examines the economic impact of constraints on coal use. 51 refs., 19 figs., 15 tabs.

4994 (INIS-mf–15071) **Saarbergwerke AG. Business report 1993.** Saarbergwerke AG, Saarbruecken (Germany). 1994. 66p. (In German). Order Number DE95726512. Source: OSTI; NTIS (US Sales Only); INIS.

This report discusses the situation of energy economics, the situation of the Saarberg Group, and the energy and pollution

abatement activities of the Saarberg Group. The annual financial statements and the statement of earnings are compiled. (HS)

0160 Health and Safety

4995 (BNL–61080) **An assessment of mercury emissions and health risks from a coal-fired power plant.** Fthenakis, V.M. (Brookhaven National Lab., Upton, NY (United States). Analytical Sciences Div.); Lipfert, F.; Moskowitz, P. Brookhaven National Lab., Upton, NY (United States). [1994]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-940853–12: Summer meeting of the American Institute of Chemical Engineers, Denver, CO (United States), 14-17 Aug 1994). Order Number DE95003963. Source: OSTI; NTIS; GPO Dep.

Title 3 of the 1990 Clean Air Act Amendments (CAAA) mandated that the US Environmental Protection Agency (EPA) evaluate the need to regulate mercury emissions from electric utilities. In support of this forthcoming regulatory analysis the U.S. DOE, sponsored a risk assessment project at Brookhaven (BNL) to evaluate methylmercury (MeHg) hazards independently. In the US MeHg is the predominant way of exposure to mercury originated in the atmosphere. In the BNL study, health risks to adults resulting from Hg emissions from a hypothetical 1,000 MW coal-fired power plant were estimated using probabilistic risk assessment techniques. This study showed that the effects of emissions of a single power plant may double the background exposures to MeHg resulting from consuming fish obtained from a localized area near the power plant. Even at these more elevated exposure levels, the attributable incidence in mild neurological symptoms was estimated to be quite small, especially when compared with the estimated background incidence in the population. The current paper summarizes the basic conclusions of this assessment and highlights issues dealing with emissions control and environmental transport.

4996 (CONF-940780–Vol.1, pp. 297-302) **An innovative continuous emissions monitor for air toxic metals.** Sappey, A.; Hyatt, D.; Sagan, F. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The Clean Air Act Amendments of 1990 defined 189 individual hazardous air pollutants which must be monitored and controlled. Of the 189 listed species, 11 are metals including arsenic, beryllium, mercury, antimony, cadmium, chromium, cobalt, lead, manganese, nickel and selenium. The current method of monitoring these species as components of flue gas requires sampling of the waste stream followed by analysis for the target metals with separate analytical procedures. The assay typically requires sample preparation and then analysis by a well-equipped analytical laboratory using, perhaps, several techniques. This facility may be distant from the waste stream and have a significant backlog. ADA Technologies is currently developing a metal air toxics Continuous Emission Monitor (CEM) for a DOE Phase I SBIR program. Detection of all 11 metal air toxics simultaneously is complicated by the fact that some of the species such as chromium, nickel, and beryllium are present in the effluent as components of the fly ash, while others such as mercury may be adsorbed on the fly ash or present in the gas phase as an aerosol. The ADA approach to CEM development relies on inductively coupled plasma (ICP) - emission spectroscopy. This very sensitive analytical technique has been combined with photodiode array (PDA) technology which allows one to detect many metal species simultaneously. The operation and performance of the CEM are discussed.

4997 (CONF-940780–Vol.1, pp. 303-308) **Assessment of mercury health risks to adults from coal combustion.** Lipfert, F.W. (Brookhaven National Lab., Upton, NY (United States)); Moskowitz, P.D.; Fthenakis, V.M.; DePhillips, M.; Saroff, L. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

In the U.S., the general population is exposed to methylmercury (MeHg) principally through the consumption of fish. There is continuing discussion about the sources of this mercury, the magnitude and trends in exposures to consumers, and their health significance. The forums for these discussions extend from the scientific literature to the U.S. Congress. Of special interest because of the health and economic study, now scheduled for completion in 1995, which will evaluate the need to regulate mercury emissions from electric utilities. The U.S. Department of Energy, Office of Fossil Energy, is sponsoring a risk assessment project at Brookhaven National Laboratory (BNL) to evaluate independently these same hazards. This report summarizes results from this project (Lipfer et al., 1994).

4998 (CONF-940780–Vol.1, pp. 309-316) **Evaluation of sorbents for enhanced mercury control.** Laudal, D.L. (Univ. of North Dakota, Grand Forks, ND (United States)); Miller, S.J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

The ability to remove mercury from power plant flue gas may become important because of the Clean Air Act Amendments' requirement that the U.S. Environmental Protection Agency assess the health risks associated with these emissions. One approach for mercury removal, which may be relatively simple to retrofit, is the injection of sorbents, such as activated carbon, upstream of existing particulate control devices. Activated carbon has been reported to capture mercury when injected into flue gas upstream of a spray dryer baghouse system applied to waste incinerators or coal-fired boilers. However, the mercury capture ability of activated carbon injected upstream of an electrostatic precipitator (ESP) or baghouse operated at temperatures between 125° and 175° is not well known. A study sponsored by the U.S. Department of Energy and the Electric Power Research Institute is being conducted at the University of North Dakota Energy & Environmental Research Center (EERC) to evaluate whether mercury control with sorbents can be a cost-effective approach for large power plants. Initial results from the study are reported in this paper. Variables of interest include coal type, sorbent type, sorbent addition rate, and temperature.

4999 (CONF-940780–Vol.1, pp. 321-328) **Measurement of mercury and other trace metals in combustion gases using active nitrogen energy transfer (ANET).** Piper, L.G. (Physical Sciences Inc., Andover, MA (United States)); Du, H.; Fraser, M.E.; Davis, S.J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 1.* 360p. Order Number DE94017535. Source: OSTI; NTIS; GPO Dep.

We describe an innovative technique to detect mercury at sub part-per-billion levels. Our approach exploits active nitrogen energy-transfer (ANET) excitation of atomic fluorescence. ANET excitation populates only one emission line of mercury at 253.7 nm. This means that the ANET spectrum can be analyzed with instrumentation of modest resolution. We use dielectric-barrier (D-B) discharge technology to generate the active nitrogen. This approach affords atmospheric-pressure operation, can excite fluorescence in gaseous, particulate, and aqueous sample matrices, and is amendable to field operation because the discharge and associated electronics can be powered by 12V batteries. This paper describes the results of a laboratory investigation that demonstrates detection of elemental mercury both in the gas phase and on particulates. In addition we show that mercuric chloride can be

detected sensitively and can be differentiated from elemental mercury. Our results indicate sensitivity limits below 100 parts per trillion in the presence of simulated flue gas.

5000 (ETDE/DE-mf--95733310) **Physical exertion and stress in mine rescue brigade members during drill using oxygen breathing apparatus.** Funkemeyer, M.; Kampmann, B.; Knoke, G.; Piekarski, C. Deutsche MontanTechnologie fuer Rohstoff - Energie - Umwelt e.V. (DMT), Essen (Germany). Hauptstelle fuer das Grubenrettungswesen; Ruhrkohle AG, Dortmund (Germany). Inst. fuer Arbeitswissenschaften; Koeln Univ. (Germany). Inst. und Poliklinik fuer Arbeits- und Sozialmedizin. Oct 1993. 100p. (In German). Order Number DE95733310. Source: OSTI; NTIS (US Sales Only).

Unlike demands on the cardivascular system of fire brigade members corresponding demands on mine rescue brigade members during drill are only documented by a small number of investigations concerning partial aspects. This work is to close the gap. (orig.)

5001 (ETDE/DE-mf--95733335) **Development of a computer-based method for accident analysis for definition of accident prevention measures. Final report.** Mieles, K. Ruhrkohle AG, Essen (Germany). Oct 1993. 105p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 01HD077. Order Number DE95733335. Source: OSTI; NTIS (US Sales Only).

The analysis of data from accident and operation events did not yield significant evidence on the real hazard potential of individual operation sites. Due to the high degree of mechanization of operations, not only the accident figures but also the causality shifted from the factor 'technology' to the factor 'organisation and human error'. Therefore the project had to follow new approaches increasing the volume of information and identifying causes in the field of 'organisation and human error'. The volume of information on accidents could be increased by a factor of 10 by proving the equivalence of accidents and first-air post records. Simultaneously time savings in identification of accident concentrations were achieved. For making use of the respective advantages, the programme 'PC-First-Aid Post Records' were developed for a PC compound system, and fielded successfully on four pilot collieries. In this context the assessment system were reviewed and successfully tested for qualitative improvement of the analyses. For efficient integration of the information on accidents into the course of operations, the prove of equivalence of safety at work and productivity is a must. A prove could be given convincingly by the assessment of 48 coalfaces, since successful accident prevention measures entailed a decrease of incidents and accordingly an increase of cost-effectiveness. Due to the complex character of safety problems, only the assessment of correlations within entire systems, i.e. behaviour-controlling measures in combination with 'technology and organisation' can be successful for reflecting reality defining targets and taking suited measures. Particularly suited for these tasks are working groups of persons who are supplied with digested data of actual events in their field of work by means of the first-aid post records. The prove could be given in an impressive way on a colliery. (Abstract Truncated)

0170 Legislation and Regulations

Refer also to citation(s) 6618

02 PETROLEUM

Refer also to citation(s) 6004, 6005

0202 Reserves, Geology, and Exploration

Refer also to citation(s) 5597, 6640

5002 (CONF-9405258--, pp. 157-161) **Optimization of dynamite source depth for seismic surveys. Part 3. Relation between the ground characteristics at the vibrating spot and spectrum of seismic wave.** Watanabe, K. (Japan National Oil Corp., Tokyo (Japan). Technology Research Center); Maruyama, R.; Amano, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports an example of having model-calculated the spectrum of seismic wave generated by the vibrating source of dynamite and ground characteristics at the vibrating spot. The following formulae are selected: three vibrating source-related conventional relational formulae which are judged appropriate mainly in theoretical research for the above model calculation. Formula which expresses the amplitude spectrum (vibrating source spectrum) calculated by conversion from the displacement velocity waveform at a unit-distance distant spot from the vibrating source, and dominant frequency of vibrating spectrum. Relational formula between the radius of inelastic domain assumed at the vibrating source, and highest pressure on the boundary of that domain. The result is written from using the above formulae for the following relations: relation (change in vibrating source spectral configuration due to the change in S-wave or P-wave velocity) between the S-wave or P-wave velocity at the vibrating spot and vibrating source spectrum. Relation among the radius of inelastic domain, S-wave or P-wave velocity at the vibrating spot, dominant frequency and quantity of dynamite for the vibrating explosion. 16 refs., 1 tab.

5003 (CONF-9405258--, pp. 162-165) **Optimization of dynamite source depth for seismic surveys. Part 4. Field parameter test for a seismic survey in Teradomari, Niigata.** Murayama, R. (Japan National Oil Corp., Tokyo (Japan). Technology Research Center); Watanabe, K.; Nakagami, K. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports an example of field experiment on the depth optimization of vibrating dynamite source. The reflection seismic survey underwent a field parameter test with an about 3km long traverse line laid in Teradomari town, Niigata prefecture. One (H) of both vibrating spots was set on a soft ground in the irrigated rice field. The other spot (Y) was done on a hard ground in the mountain. Their depth was done at 25m or 50m. The following result is written from interpreting the data obtained through the above test: the deep reflection wave generated at the vibrating depth of 25m is two to three times as strong as that of 50m. At the same vibrating depth, the reflection wave from the spot H is several times as strong as that from Y. Though very strong, the surface wave generated from the spot H at the depth of 25m can be controlled, with a receiver array and prospector filter, to a double or triple of the intensity of that done at the depth of 50m. 3 refs., 5 figs.

5004 (CONF-9405258--, pp. 275-279) **Reservoir thermal structure in Niigata oilfield.** Hayakawa, M. (Tokai University, Tokyo (Japan). School of Marine Science and Technology). Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper explains the thermal structure of reservoirs in Niigata oilfield. Through modeling research on the oil generation-related thermal history, the conclusion was recently published that anticlinal structure has been rapidly growing in the Niigata plains since 4.3 million years ago, that the main depth of oil and gas generation zones is less than 2500m and more than 3000 to 4000m, respectively, and that both oil and gas have been being actively generated since 2 million ago. However, Hayakawa infers that the gas layer (or oil layer in the source rock stratum) existing at the

depth of about 5000m was generated 12 million years ago. The above inference is set forth as follows: the generation-related heat source is judged to be immense basalt generated (15 million years ago) due to the formation of the Sea of Japan. Hypothesizing that the spherical heat source is 10km in radius, it is calculated that its initial temperature of 1000°C requires a period of about 3 million years for being lowered to 200°C. 14 refs., 7 figs.

5005 (CONF-9405258–, pp. 405-408) **Application of magnetotellurics to petroleum exploration in Japan. Part 4. Evaluation of array measurement.** Takakura, S. (Japan National Oil Corp., Tokyo (Japan)); Matsuo, K.; Kishimoto, M. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports an example of having evaluated the MT array measurement. Thirty stations were laid, at an interval of 200m, along a 6km long traverse line with eight additional ones which were dispersed almost along the above line lengthened. At seven stations in total, i.e., five stations along the traverse line, one dispersed station and one referential station, two components of electric field and three components of magnetic field were simultaneously MT-measured by synchronizing, as a system by quartz oscillating clock, three MT measurement units V5-16 produced by Phoenix (Canada). The frequency was measured within a band of 320Hz to 0.00055Hz. The following is verified through comparison between the result of analysis with the data at all the stations and that at the limited stations of which the interval was longer than 600m and longer than 1km: the high-density array measurement actually has its expected advantage of correcting the static effect and heightening the resolving power of shallow structure. The apparent resistivity is influenced by the anomaly of local resistivity in the vicinity of measuring spot for the electric field. 5 refs., 4 figs.

5006 (CONF-9405258–, pp. 464-468) **Formation model experiment of tilt-coil directional induction logging.** Kashihara, K. (Japan Petroleum Exploration Co. Ltd., Tokyo (Japan)); Miyairi, M.; Sato, M.; Niitsuma, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

This report presented the results of model experiment of the directional electromagnetic induction by a tilt-coil arrangement. The formation model of specific resistance boundary was made by dipping the PVC cylinder packed with polystyrene foam in a tank containing salt water. A PVC pipe with radius of 3 cm was passed through the model to simulate the well. The transmitting/receiving coil (radius: 2 cm, pitch: 20 cm) arranged in the well with an inclination of 30° was rotated near the boundary surface. The running direction and the inclination direction could be obtained from the direction which exhibited the maximum response voltage. The coil was moved toward the depth direction. The boundary position could be obtained from the depth where the maximum difference between the maximum and minimum response voltages was exhibited. These results showed that this method was effective to the model. The measurement results of the horizontal well made by dipping the rock block in salt water were also described. 2 refs., 11 figs., 1 tab.

5007 (DOE/EIA–TR/0575) **Oil and gas resources of the Fergana Basin (Uzbekistan, Tadzhikistan, and Kyrgyzstan).** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Jan 1995. 148p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004722. Source: OSTI; NTIS; GPO; GPO Dep.

This analysis is part of the Energy Information Administration's (EIA's) Foreign Energy Supply Assessment Program (FESAP). This one for the Fergana Basin is an EIA first for republics of the former Soviet Union (FSU). This was a trial study of data availability and methodology, resulting in a reservoir-level assessment of ultimate recovery for both oil and gas. Ultimate recovery, as used here, is the sum of cumulative production and remaining Proved plus Probable reserves as of the end of 1987. Reasonable results were obtained when aggregating reservoir-level values to the basin level, and in determining general but important distributions of across-basin reservoir and fluid parameters. Currently, this report represents the most comprehensive assessment publicly available for oil and gas in the Fergana Basin. This full report provides additional descriptions, discussions and analysis illustrations that are beneficial to those considering oil and gas investments in the Fergana Basin. 57 refs., 22 figs., 6 tabs.

5008 (IFP–41398) **New approach of pressure tests adapted to horizontal wells- Towards a best knowledge of petroleum deposits.** Quintao Lara, A. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Paris-6 Univ., 75 (France). May 1994. 271p. (In French). Order Number DE95729625. Source: OSTI; NTIS (US Sales Only).

The main goal of this work is to define a new type of pressure tests better adapted to the specific features of horizontal wells. At the same time, our objective is to get a better knowledge of the well conditions and a more reliable characterization of the heterogeneities that can influence the oil production. The first part presents the state-of-the-art concerning the theoretical and practical aspects of horizontal well pressure tests. This review is done in order to answer the question: Why are conventional tests not suitable for horizontal wells. In the second part, we propose a new pressure test procedure - selective tests - that consists of testing limited sections of the horizontal well. The importance of production logs to choose the sections to be tested selectively is focused on. By numerical examples, we show that this kind of test is especially useful to identify properties'variation along the drainhole. We study two cases: a well with variable skin and a well in a sand-shale reservoir with a bottom aquifer. First, the problem is treated supposing that the well-reservoir system is known a priori. Secondly, the inverse problem is considered: we simulate a real situation where only some characteristics of the system are known. For all the cases examined the results show clearly the superiority of the selective tests compared with the conventional ones. In the last part, we develop a new analytical solution to study the transient well pressure behaviour in a heterogeneous reservoir. The approach, based on the perturbation method, was applied to situations that are not well handled by standard finite difference numerical models, as the case of a shale lens inclined in relation to the well axis. (author).

0203 Drilling and Production

Refer also to citation(s) 5044

5009 (DOE/BC/14950–4) **Enhanced oil recovery utilizing high-angle wells in the Frontier Formation, Badger Basin Field, Park County, Wyoming. Final report for the period October 1992–October 1993.** Walker, J.P.; Fortmann, R.G. Sierra Energy Co., Reno, NV (United States). Dec 1994. 76p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14950. Order Number DE95000114. Source: OSTI; NTIS; GPO Dep.

Badger Basin Field, discovered in 1931, produces at stripper rates from low-permeability fractured sandstones of the Upper Cretaceous Frontier Formation. Only 15% of the estimated 25 million barrels of oil originally in-place will be produced from the twenty-two attempted vertical completions. This project will increase recoverable reserves through a better understanding of the reservoir and factors which control production. Characterization of the reservoir has been accomplished through an integrated engineering, geological and geophysical approach. Production data, drilling and completion techniques, and relative location of wells on the anticline were reviewed and related to productivity. Literature was reviewed for interpretations on preferred flow directions on anticlinal structures. A structure map of the producing Frontier reservoir was constructed. Porosity development and its relationship to fracture networks was examined petrographically. Fractures in core

were described and oriented using paleomagnetic techniques. Azimuths of fractures in outcrop were compared to fracture azimuths measured in the core. A 17 square-mile 3D seismic survey was designed, acquired and processed. Interpretation is being performed on a Sun workstation using Landmark Graphics software. Time-structure and amplitude-distribution maps will be constructed on three Frontier horizons. A location for a high-angle well will be chosen. The slant/horizontal test will be drilled and completed to increase recovery of reserves. Transfer of successful technologies will be accomplished by technical publications and presentations, and access to project materials, data, and field facilities.

5010 (DOE/BC/14958–8) **Green River Formation water flood demonstration project. Report for the period October 1992–March 1994.** Pennington, B.I. (Lomax Exploration Co., Salt Lake City, UT (United States)); Lomax, J.D.; Neilson, D.L.; Deo, M.D. Lomax Exploration Co., Salt Lake City, UT (United States). Dec 1994. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-93BC14958. Order Number DE95000113. Source: OSTI; NTIS; GPO Dep.

The current project targeted three fluvial deltaic reservoirs in the Uinta Basin, Utah. In primary recovery, the performance of the Monument Butte unit was typical of an undersaturated reservoir whose initial pressure was close to the bubble point pressure. The unit was producing at a rate of 40 stb/day when the water flood was initiated. The unit has been producing at more than 300 stb/day for the past four years. The reservoir characteristics of Monument Butte were established in the geologic characterization study. The reservoir fluid properties were measured in the engineering study. Results of a comprehensive reservoir simulation study using these characteristics provided excellent match with the field production data. Extended predictions using the model showed that it would be possible to recover a total of 20–25% of the oil in place. In the Travis unit, logs from the newly drilled 14a-28 showed extensively fractured zones. A new reservoir was discovered and developed on the basis of the information provided by the formation micro imaging logs. This reservoir also behaved in a manner similar to undersaturated reservoirs with initial reservoir pressures close to the reservoir fluid bubble point. The water flood activity was enhanced in the Travis unit. Even through the reservoir continued to be gradually pressurized, the water flood in the Travis unit appeared to be significantly affected by existing or created fractures. A dual-porosity, dual permeability reservoir model provided a good match with the primary production history. The well drilled in the Boundary unit did not intersect any producible zones, once again illustrating the unique challenges to developing fluvial deltaic reservoirs.

5011 (DOE/CE/15600–T3) **Method for cutting steam heat losses during cyclic steam injection of wells. Third quarterly report.** Gondouin, M. Southern California Research Corp., San Rafael, CA (United States). 10 Dec 1994. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG49-93CE15600. Order Number DE95004113. Source: OSTI; NTIS; GPO Dep.

The proposals jointly submitted with Ms. Joyce Kostura to the DOE in response to the Class 3 Oil Program P.O.N. for a field test of our respective technologies in a Midway Sunset lease, which we had acquired for this purpose, were both rejected. The owner of the adjacent lease is, however, considering making a joint field test covering both leases. This might allow him to revive at least 19 vertical wells, currently shut-in or marginally economic. Without DOE funding, the new project requires that the cost of the single vertical cased well, equipped with twin horizontal drainholes, be kept to a minimum in order to remain economically-viable. This has led us to re-design the Downhole Hardware to greatly reduce fabrication costs, while retaining all the required technical features. An analysis of the thermal stresses in the Special Casing Joints has shown that some allowance for free thermal expansion of the curved channels was preferable to the all-welded design approach previously considered, which required larger steel sections to withstand the large thermal stresses. In the revised design, both of the Lower Special Joints (TLSJ and BLSJ) consist of a standard 30 ft joint of casing with a fixed bottom plate and a mobile top plate, in which the corresponding curved channel top end is welded. In this way, the thermal expansion of the 30 ft long channel pipes, which is about 0.3" for the highest steam temperature considered,is absorbed by a sliding motion of the upper plate in each Lower Special Joint (TLSJ or BLSJ). The main benefits of this revision are: (1) the possibility of using thinner-wall and lighter pipes, (2) the complete elimination of any gun-d 'ling tasks, (3) a considerable reduction in machining time and labor, (4) the use of standard commercial Oil Field threaded connections, available off the shelf.

5012 (LBL–36449) **Note on the validity of the Kozeny-Carman formulas for consolidated porous media.** Schlueter, E.M. (Lawrence Berkeley Lab., CA (United States). Earth Sciences Div.); Witherspoon, P.A. Lawrence Berkeley Lab., CA (United States); California Univ., Berkeley, CA (United States). Oct 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC22-89BC14475. Order Number DE95004820. Source: OSTI; NTIS; GPO Dep.

The simplest and oldest capillaric model is one representing the porous medium by a bundle of parallel straight capillaries of uniform radius. In deriving this Kozeny-Carman model, the multiple connectivity of the pore space is completely neglected. The authors undertook this research with four main objectives in mind: (1) to re-examine the effective medium theory to treat conductor networks based on the distribution of individual conductances, (2) to study the region of validity of the effective medium theory by comparing its results with conductances evaluated numerically using large 3-D simple cubic networks in which the values of the conductances are chosen by a Monte Carlo procedure from one of several distributions, (3) to compare results with the critical-path analysis which focuses on the details of the critical paths along which much of the flow must occur (4) to study the validity of the Kozeny-Carman formulas for consolidated porous media as they relate to the microscopic spatial variations of channel dimensions using the effective medium theory, network theory, and the critical path analysis, and ultimately (5) to compare the analytical results thus obtained with experimental results for a variety of consolidated porous materials.

5013 (NEI-NO–461) **Foam as a gas-blocking agent in petroleum reservoirs.** Hanssen, J.E. Hoegskolesenteret i Rogaland, Stavanger (Norway). Nov 1992. 197p. Order Number DE95006001. Source: OSTI; NTIS.

This work is a study of the properties of foam in porous media representative of reservoir rock. Because of its low viscosity, free gas present in a reservoir often flows preferentially into a production well designed to produce oil. Gas that is injected in order to improve oil recovery may sweep only a small portion of the reservoir, if its low viscosity and density cause it to flow primarily in gravity tongues or to channel through to a production well in highly permeable zones. Foam can be generated inside the reservoir rock by injecting an applicable surfactant solution in some manner of combination with the gas. The resultant foam can improve oil production by selectively reducing gas mobility in the pores. The liquid films that constitute the foam create bridges across the pore throats which, in effect, make the gas discontinuous. The main focus of this work is on characterizing a state of foam where gas is persistently blocked by foam films. Flow experiments in packed columns, sandstone cores, and glass micromodels are reported. The conditions for creating such gas-blocking foams, the influence of a range of parameters on their properties, the interaction between foam and oil in the pores, and the mechanisms of flow in foam-containing porous media are particular subjects investigated. A wide range of surfactants are use to create foam, including fluorinated surfactants for aqueous as well as non-aqueous systems. The results may be applied in selecting foaming agents for use in reservoir processes and in obtaining a better description and modeling of flow in reservoirs containing foam.

0204 Processing

Refer also to citation(s) 4888, 4890, 5545, 5546, 6163, 6164

0205 Products and By-Products

5014 (IFP–41371) **Synthesis, characterization and application to lubricating oil of phospho sulfured polymers**

additives. Keromest, C. Institut Francais du Petrole (IFP), 92 - Rueil-Malmaison (France); Paris-6 Univ., 75 (France). Jul 1992. 134p. (In French). Order Number DE95729626. Source: OSTI; NTIS (US Sales Only).

The work relates to multifunctional lubricating oil additives, providing Viscosity Index Improver and antiwear-extreme-pressure properties. Dithiophosphorylated polymers are obtained by reacting dithioalcohols or dithioacids with functional polymers resulting from the copolymerization of alkyl methacrylates with maleic anhydride or glycidyl methacrylate, or from the grafting of maleic anhydride on ethylene-propylene copolymers. The polymethacrylate backbone additives, tested on a four-ball extreme-pressure tester, do not show improved performances; on the contrary, lubricating formulations containing the polyolefin backbone additive show improved performances when compared to zinc dithiophosphates, generally used as antiwear - extreme-pressure additives in automotive motor oils. (author).

0206 Health and Safety

Refer also to citation(s) 5434

0207 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6163, 7050

5015 (CONF-9403188–, pp. 147-158) **Oil and related issues. U.S. outlook.** Burns, T. (Chevron Corp., (United States)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy consultation, Mr. Burns from Shevron Co., Ltd. lectured on analysis of the petroleum price level and the Asian market. From the historical view, the oil price at the real value level had been stabilized at the average of US$15/barrel for more than 100 years to 1972. The fourth Middle East War in 1973 and the OPEC's oil strategy caused the oil price to soar. Therefore, the policies of oil consumer countries have been laid down even now based on oil supply stoppage they suffered at that time. The government of many oil consumer countries want to reduce the demand for petroleum by imposing the oil tax so that people compare the oil price with prices of other competitive fuels and buy less oil. For OPEC countries, a possible problem is how to procure funds required to secure the production capacity to meet the growing demand in the world. A rapid annual growth of oil demand in the Asian market may be 1 - 1.5% on a long-term basis. In particular, China has actually a very large growth of petroleum consumption which may be underestimated at present. 4 figs., 2 tabs.

5016 (DOE/EIA–0109(94/12)) **Petroleum supply monthly, December 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Dec 1994. 151p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004666. Source: OSTI; NTIS; GPO; GPO Dep.

Total demand for refined petroleum products (measured as products supplied) for November 1994 averaged 17.2 million barrels per day, 2 percent lower than October 1994 and 3 percent lower than November 1993. Unseasonably warm November temperatures, 11 percent warmer than normal and 16 percent warmer than last year, slackened demand for both distillate fuel oil and residual fuel oil. The economy continued to improve in November, evidenced by strong production at the Nation's factories, mines, and utilities. Pipeline movements of distillate and gasoline out of the Houston, Texas, area resumed after a temporary repair was completed on the Colonial Pipeline Company's Number 2 line where it crossed the San Jacinto River. Colonial's major refined products trunkline to the Northeast was heavily damaged by heavy rains and extensive flooding several weeks earlier, and the installation of the temporary pipeline link was completed and operational on November 2, 1994.

5017 (DOE/EIA–0370(94)) **Oil and gas field code master list 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Jan 1995. 446p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004719. Source: OSTI; NTIS; GPO; GPO Dep.

This is the thirteenth annual edition of the Energy Information Administration's (EIA) Oil and Gas Field Code Master List. It reflects data collected through October 1994 and provides standardized field name spellings and codes for all identified oil and/or gas fields in the United States. The master field name spellings and codes are to be used by respondents when filing the following Department of Energy (DOE) forms: Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," filed by oil and gas well operators (field codes are required from larger operators only); Forms FERC 8 and EIA-191, "Underground Gas Storage Report," filed by natural gas producers and distributors who operate underground natural gas storage facilities. Other Federal and State government agencies, as well as industry, use the EIA Oil and Gas Field Code Master List as the standard for field identification. A machine-readable version of the Oil and Gas Field Code Master List is available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650. In order for the Master List to be useful, it must be accurate and remain current. To accomplish this, EIA constantly reviews and revises this list. The EIA welcomes all comments, corrections, and additions to the Master List. All such information should be given to the EIA Field Code Coordinator at (214) 953-1858. EIA gratefully acknowledges the assistance provides by numerous State organizations and trade associations in verifying the existence of fields and their official nomenclature.

5018 (DOE/EIA–0520(94/12)) **International petroleum statistics report.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1994. 73p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004481. Source: OSTI; NTIS; GPO; GPO Dep.

This document is a monthly publication that provides current international oil data. The Report presents data on international oil production, demand, imports, exports, and stocks. Section 1 contains time series data on world oil production, and on oil demand and stocks in the OECD. Section 2 presents an oil supply/demand balance for the world. This balance is presented in quarterly intervals for the most recent two years. Section 3 presents data on oil imports by OECD countries. Section 4 presents annual time series data on world oil production and oil stocks, demand and trade in OECD countries.

5019 (DOE/FE–0322) **A guide for the gas and oil industry.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (United States). Dec 1994. 61p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004504. Source: OSTI; NTIS; GPO Dep.

This guide has been prepared to assist those in the natural gas and oil industry who may not be familiar with how the Federal government, particularly the U.S. Department of Energy (DOE or Department), does business with private sector companies. Basic information is provided on what DOE is trying to do, why it wants to work with the natural gas and oil industry, how it can work with companies, who to contact, and where to inquire for further information. This last item is noteworthy because it is important for users of this guide to be able to access information about subjects that may interest them. Selected other Federal agencies and their activities related to those of DOE's Office of Fossil Energy (FE or Fossil Energy) also are included in this document as Appendix A. This guide provides an address and/or phone number for every topic covered to prevent any information impasse. If a question is not adequately answered by the guide, please do not hesitate to contact the appropriate person or office. It is hoped that the information provided in this guide will lead to a better understanding of the mission, roles, and procedures of DOE and result in more and better cooperative working relationships between the natural gas and oil industry and DOE. Such relationships will provide a significant benefit to our Nation's economic, technological, and energy security.

5020 (NEDO-GET–9214) **Cooperation project for making petroleum consumption in developing countries efficient/**

fundamental survey on petroleum consumption in developing countries. Invitation of engineers of developing countries to Japan (from Thailand). New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 222p. (In Japanese). Order Number DE95730257. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Under the research contract with NEDO and as a part of the measures taken to make petroleum consumption efficient in the Asia-Pacific region, the International Center of Environmental Technology Transfer carried out a project on training of engineers from administrative organs, universities and companies in Thailand which are tackling the environment/energy conservation problems. This is a project to contribute to promotion of energy conservation environmental measures taken according to a rapid economic growth in Thailand. The number of the trainees is eleven, and the period for training is February 12-26, 1991. The focus of the training is on the environmental preservation problem, the industrial pollution in Japan, in particular. The trainees learn how public pollution is generated and how it is abated and know know-how for environmental preservation technology measures. Guidance is given as to environmental preservation measures and the information system such as a summary of pollution control systems, environmental preservation measures and the law system, roles of the central government and local governmental organizations, field sharing, business budget plans, and raising of funds. Most up-to-date technical information on environmental preservation is introduced to them at the Chubu Electric Co. and Showa Yokkaichi Sekiyu Co. Information exchanges with engineers were made for transfer of Japanese environmental technology to Thailand. 10 refs.

5021 (NEDO-GET–9216-2) **Cooperation project for making petroleum consumption in developing countries efficient/ fundamental survey on petroleum consumption in developing countries. Part 2. Cooperation survey on making petroleum consumption efficient (Malaysia).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1992. 100p. (In Japanese). Order Number DE95730262. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

Possibilities of assisting Malaysia with environmental protection technology are studied by investigating the situation of environmental pollution mostly from the atmosphere there and the actual status of environmental preservation measures. Energy sources used in Malaysia are petroleum, hydroelectric power, natural gas and coal, and a large scale introduction of natural gas is planned making a good use of the natural resource. As to energy consumption, petroleum is much consumed in the industry and transportation. As viewed from energy consumption to GDP, GDP unit requirement of energy consumption is 0.69 TOE/$ in 1990 which is larger than 0.17 in Japan. It means that measures for energy conservation should be taken. Air pollutant exceeds the allowable value, 260 $\mu g/m^3$ in the industrial areas, but is barely within the allowable value in the other areas. Results of the survey indicate that air pollution is increasing in partial urban areas/industrial areas, but generally it isn't yet conspicuous as a pollution problem. It seems that before the air pollution becomes the problem, attention is paid to the problems such as water pollution. 10 refs., 35 figs., 22 tabs.

5022 (NIPER–620) **Projections of the impact of expansion of domestic heavy oil production on the U.S. refining industry from 1990 to 2010. Topical report.** Olsen, D.K. (National Institute for Petroleum and Energy Research, Bartlesville, OK (United States). ITT Research Institute); Ramzel, E.B.; Strycker, A.R.; Guariguata, G.; Salmen, F.G. National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States). Dec 1994. 312p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-83FE60149. Order Number DE95000115. Source: OSTI; NTIS; GPO Dep.

This report is one of a series of publications assessing the feasibility of increasing domestic heavy oil (10° to 20° API gravity) production. This report provides a compendium of the United States refining industry and analyzes the industry by Petroleum Administration for Defense District (PADD) and by ten smaller refining areas. The refining capacity, oil source and oil quality are analyzed, and projections are made for the U.S. refining industry for the years 1990 to 2010. The study used publicly available data as background. A linear program model of the U.S. refining industry was constructed and validated using 1990 U.S. refinery performance. Projections of domestic oil production (decline) and import of crude oil (increases) were balanced to meet anticipated demand to establish a base case for years 1990 through 2010. The impact of additional domestic heavy oil production, (300 MB/D to 900 MB/D, originating in select areas of the U.S.) on the U.S. refining complex was evaluated. This heavy oil could reduce the import rate and the balance of payments by displacing some imported, principally Mid-east, medium crude. The construction cost for refining units to accommodate this additional domestic heavy oil production in both the low and high volume scenarios is about 7 billion dollars for bottoms conversion capacity (delayed coking) with about 50% of the cost attributed to compliance with the Clean Air Act Amendment of 1990.

0209 Environmental Aspects

Refer also to citation(s) 6571

5023 (SFT-R–93-31) **Environmental effects of acute oil spills. Marine environment.** Moe, K.A.; Lystad, E.; Nesse, S.; Selvik, J.R. Statens Forurensningstilsyn, Oslo (Norway). 1993. 138p. (In Norwegian). Order Number DE95723922. Source: OSTI; NTIS; INIS.

Biological effects as result of acute oil spill pollution may be considered as a product of: the existing biophysical conditions; occurrence and appearance of organisms in time and space; the fate of the oil in time and space; the vulnerability of the various organisms for oil and oil derivatives in a three-dimensional perspective. In general, it seems as every individual oil spill has its own nature and dynamics, inter alia because the physical, chemical and biological conditions never are the same. This means that the properties of the recipients often are more important than the amount of oil that is spilled. This may be exemplified by two oil spills in recent time. Exxon Valdez (1989), where 35000 ton oil were released in a partly closed sea area, caused considerable effects. From Braer (1993) the double amount of oil was spilled, but in an open sea area and at a time where the presence of dense concentrations of environmental components was limited, and the physical conditions favorable with respect to evaporation and dilution. Preliminary results show that the environmental effects were very limited. 311 refs., 32 figs., 10 tabs.

0220 Transport, Handling, and Storage

5024 (WHC-SD-WM-OTR–155) **Operational test report for WESF diesel generator diesel tank installation.** Schwehr, B.A. Westinghouse Hanford Co., Richland, WA (United States). 2 Aug 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003282. Source: OSTI; NTIS; INIS; GPO Dep.

The WESF Backup Generator Underground Diesel Tank 101 has been replaced with a new above ground 1000 gallon diesel tank. Following the tank installation, inspections and tests specified in the Operational Test Procedure, WHC-SD-WM-OTP-155, were performed. Inspections performed by a Quality Control person indicated the installation was leak free and the diesel generator/engine ran as desired. There were no test and inspection exceptions, therefore, the diesel tank installation is operable.

5025 (WSRC-MS–94-0529) **Electrical isolation problems in underground fuel storage tanks and piping.** Vessel, E.M.; Jenkins, C.F. Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950304–4: National Association of Corrosion Engineers corrosion conference, Orlando, FL (United States), 20-25 Mar 1995). Order Number DE95003190. Source: OSTI; NTIS; GPO Dep.

Eleven underground fuel storage tanks have been replaced at the Department of Energy's Savannah River Site since 1986. The replacement tanks are steel tank-in-tank construction with the exterior surface coated and cathodically protected. The annular space between tanks is monitored for leaks, thus meeting current Federal and State environmental regulations. Piping connected to the tanks is also coated and cathodically protected (CP). The two CP systems are designed to be isolated from each other and from the plant electrical system, in order to improve the efficiency of the anodes by restricting the overall area each protects. Problems with CP arose following maintenance activity at some of the tanks. Investigation showed that the electrical isolation had been violated. This required examination and replacement of several special pipe fittings and bolt isolation kits. A breakdown of communications with maintenance personnel in the field is often the source of problems and in this case led to compromising the corrosion protection.

0230 Properties and Composition

5026 (ETDE/DE-mf–95733344) **Heterocompounds in mineral oils of different classification.** Voss, K.P. Technische Univ. Clausthal, Clausthal-Zellerfeld (Germany). Mathematisch-Naturwissenschaftliche Fakultaet. 7 Jun 1993. 222p. (In German). Order Number DE95733344. Source: OSTI; NTIS (US Sales Only).

Sulphur compounds were to be isolated and identified in mineral coils of different origin and with different degrees of maturity. In addition, experiments were made on the accumulation and characterisation of oxygen and nitrogen compounds. Mineral oils from North West Germany, the North Sea and Baltic Sea as well as tar sands and shale oils of different origin were used for the experiments. The different classes of sulphur compounds were to be quantified and related to the origin and maturity of the mineral oil. Further, it was attempted to relate the alkoylated positional isomers on anellated thiophenes to the degree of maturity of the oil. A generally valued separation process is required for isolating sulfidic and thiophenic compounds and measuring them separately, also in mineral oils with low sulphur concentrations (<1%). (orig./HS)

0250 Combustion

5027 (UCRL-ID–118564) **Ethylene oxidation chemistry in a well-stirred reactor.** Marinov, N. (Lawrence Livermore National Lab., CA (United States)); Malte, P. Lawrence Livermore National Lab., CA (United States). Sep 1994. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95004823. Source: OSTI; NTIS; GPO Dep.

Ethylene is an important intermediate in the combustion of methane, larger aliphatic hydrocarbons, and aromatics. Detailed fuel-lean $C_2H_4H_2O$/air well-stirred reactor data by Thornton were used to analyze reported combustion chemistry mechanisms and the development of this study's ethylene oxidation mechanism. The data set had been obtained for the temperature range 1,003 to 1,253 K and ethylene-oxygen equivalence ratio range 0.086 to 0.103, at atmospheric pressure. Mechanisms were derived from reaction sets of Westbrook and Pitz, and Dagaut, Cathonnet and Boettner. Examination of each reported mechanism indicated unusually large kinetic rates for the vinyl decomposition reaction were used in order to obtain agreement with the Thornton data set. An ethylene oxidation model was developed in order to address the mechanistic problems of the previous models. This study's mechanism well simulated the overall rate of ethylene oxidation and concentration profiles of CO, CO_2, H_2, CH_2O, C_2H_2, CH_3OH, CH_4, and C_2H_6. Successful predictions by the model were dependent on a new high temperature vinyl oxidation reaction route, $C_2H_3 + O_2 = CH_2CHO + O$ with a branching ratio of 1.19–1.21 at 1,053 K to 1.63–2.47 at 1,253 K. The branching ratio values were dependent upon the extent of fall-off for the $C_2H_3 + O_2 = CH_2O + HCO$ reaction. 132 refs.

03 NATURAL GAS

Refer also to citation(s) 6004, 6005

5028 (DOE/METC–94/1002, pp. 359-369) **Development of the natural gas systems analysis model (GSAM).** Haas, M. (ICF Resources Incorporated, Fairfax, VA (United States)); Pepper, W.; Rose, J. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-92MC28138. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this research is to create a comprehensive, nonproprietary, microcomputer model of the North American natural gas system. The model is to explicitly evaluate key components of the natural gas system, including resource base, exploration and development, extraction technology performance and costs, transportation and storage, and end use. It will be used to evaluate alternative METC Natural Gas R&D strategies and to estimate the impact of federal energy and environmental policy initiatives on domestic natural gas potential. The three-year project timetable has been accelerated to provide a working prototype model by December 1993.

5029 (DOE/METC–94/1002, pp. 370-378) **Preliminary analysis of GASIS user needs.** Vidas, E.H. (Energy and Environmental Analysis Inc., Arlington, VA (United States)); Hugman, R.H. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-93MC28139. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

A "User Needs" assessment for the planned GASIS data system has been underway since September of this year. It is designed to cover all major segments of the gas industry, including major and independent producers, state and federal agencies, pipelines, research organizations, banks, and service companies. The objectives of the evaluation are: (1) to design GASIS to meet the needs of industry and the research community, (2) to determine potential applications for GASIS in order to better design the database, (3) to prioritize data categories and specific data collection activities; (4) to evaluate industry software and data exchange requirements.

0302 Reserves, Geology, and Exploration

Refer also to citation(s) 5007, 5048, 5059, 5060, 5062

5030 (DOE/MC/26026–3947) **A novel geotechnical/geostatistical approach for exploration and production of natural gas from multiple geologic strata. Technical progress report, July–September 1994.** Brunk, R.G. West Virginia Coll., Beckley, WV (United States). Oct 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-89MC26026. Order Number DE95004304. Source: OSTI; NTIS; GPO Dep.

The Test Well No. 4 Project plans to identify potential coalbed methane drill sites in the State of Alaska. There are two primary objectives in this activity. First, research and drilling in Alaska will provide much needed data on coal and methane in that state. Second, if the well is successful, gas produced will be used to fulfill the energy needs of Alaskan villages. Work on the College of West Virginia Multistrata Wells continued with plans for reworking the entire system. The College focused on preparing a detailed and comprehensive work plan involving workover on each well and installation of a compressor into the main gathering line. When this work is complete, CWV will be able to place the three project wells back on line and begin production to provide for the on campus energy needs of the College. Planning was initiated on a project to demonstrate newly developed technologies for multi-strata gas and water production to enhance commercial applications. The Morcinek Mine area in Poland was identified as a prime target for the capture of methane gas and the clean-up of associated brine. CWV subcontractors shall implement a system to capture coalbed methane and brine, and to utilize the captured gas to operate brine clean-up equipment. This equipment will include a submerged evaporator and a reverse osmosis unit. In short, this technology will take brine and produce potable water and commercial salt.

5031 (DOE/MC/28139–3929) **Development of a Gas Information System (GASIS). Quarterly report, June 1994–August 1994.** Energy and Environmental Analysis, Inc., Arlington, VA (United States). Sep 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-93MC28139. Order Number DE95000022. Source: OSTI; NTIS; GPO Dep.

The following items describe technical progress on the GASIS project during the quarter from June through August, 1994 for contract no. DE-AC21-93MC28139. During this reporting period, work was performed on Task 1, Obtain User Input, Task 2, Develop Source Directory, Task 3, Develop Natural Gas Data System, and Task 4, Technology Transfer. No work was done on Task 5 Storage Media.

5032 (DOE/METC–94/1002, pp. 203-216) **Integrated seismic study of naturally fractured tight gas reservoirs.** Mavko, G.M. (Stanford Univ., CA (United States)); Nur, A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

In tight formations, which can include sandstones, shales, limestones, and coal, often the only practical means to extract the gas is by exploiting the increased drainage surface provided by natural fracture zones. The practical difficulties that must be overcome before effectively using these fractures include: locating the position and orientation of fracture zones, determining the intensity of fracturing, and characterizing the spatial relationships of these fractures relative to reservoir heterogeneities which might enhance or inhibit the eventual gas flow. Reflection seismic methods are, and will continue to be, the key geophysical tool for imaging these heterogeneities in the subsurface of the earth. However, in spite of great advances in field acquisition techniques and computer processing power, the primary product of conventional seismic work is still only the spatial pattern of reflectivity, which is a measure of velocity variations. Most of the amplitude information goes unused. Although fracture zones may have a reflectivity signature, more often they will not, because of steeply dipping angles, limited offset range in the acquisition, a subtle impedance mismatch, or too thin a fractured zone relative to the wavelength. In fact, there is probably no single seismic attribute that will always tell explorers what they need to know about fracture zones. The authors objective, in the project, is to integrate the principles of rock physics into a quantitative interpretation scheme that exploits the broader spectrum of fracture zone signatures: (1) anomalous compressional and shear wave velocities; (2) Q and velocity dispersion; (3) increased velocity anisotropy; and (4) amplitude variation with offset (AVO) response.

5033 (DOE/METC–94/1002, pp. 217-221) **Fracture detection, mapping, and analysis of naturally fractured gas reservoirs using seismic technology.** Lynn, H. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-92MC28135. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

There are a number of producing gas fields in the US where production is controlled by natural fractures. The host rock may consist of low porosity, low permeability formations, and wells completed in the unfractured rock have low productivity. On the other hand, wells intercepting fractured rocks may show good production. The objective of the research under this contract is to improve the technology for detecting fractures by surface geophysical methods. This remote detection of fractures will allow optimum placement of vertical or horizontal wells.

5034 (DOE/METC–94/1002, pp. 222-227) **Geotechnology for low permeability gas reservoirs.** Lorenz, J.C. (Sandia National Labs., Albuquerque, NM (United States)); Warpinski, N.R.; Teufel, L.W. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC04-76DP00789. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives of this program are (1) to use and refine a basinal analysis methodology for natural fracture exploration and exploitation, and (2) to determine the important characteristics of natural fracture systems for their use in completion, stimulation and production operations.

5035 (DOE/METC–94/1002, pp. 228-243) **LBL/Industry Heterogeneous Reservoir Performance Definition Project.** Majer, E.L. (Lawrence Berkeley Lab., CA (United States)); Long, J.C.S. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

One of the problems facing the petroleum industry is the recovery of oil from heterogeneous, fractured reservoirs and from reservoirs that have been partially depleted. In response to this need, several companies, notably British Petroleum USA, (BP) and Continental Oil Company (Conoco), have established integrated reservoir description programs. Concurrently, LBL is actively involved in developing characterization technology for heterogeneous, fractured rock, mainly for the DOE's Civilian Nuclear Waste Program and Geothermal Energy programs. The technology developed for these programs was noticed by the petroleum industry and resulted in cooperative research centered on the petroleum companies test facilities. The emphasis of this work is a tightly integrated interdisciplinary approach to the problem of characterizing complex, heterogeneous earth materials. In this approach, the authors explicitly combine the geologic, geomechanical, geophysical and hydrologic information in a unified model for predicting fluid flow. Described here is a comprehensive program between DOE and industry that uses this philosophy through an integrated field testing effort that focuses on realizing techniques for providing an integrated petroleum reservoir description. The work described here is the work being carried out at Conoco's Newkirk test facility. Later phases of the work will involve actual application at a production field.

5036 (DOE/METC–94/1002, pp. 247-257) **Preliminary results on the characterization of cretaceous and Lower Tertiary low-permeability (tight) gas-bearing rocks in the Wind River Basin, Wyoming.** Johnson, R.C. (Geological Survey, Denver, CO (United States)); Keefer, W.R.; Rice, D.D.; Finn, T.M.; Keighin, C.W.; Flores, R.M.; Nuccio, V.F.; Pawlewicz, M.J.; Szmajter, R.J. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The Wind River Basin is a structural and sedimentary basin in central Wyoming that was created during the Laramide orogeny from Late Cretaceous through Eocene time. The objectives of the Wind River Basin tight gas sandstone project are to define the limits of the tight gas accumulation in the basin and to estimate in-place and recoverable gas resources. The approximate limits of the tight gas accumulation will be defined from available drillhole information. Geologic parameters, which controlled the development of the accumulation, will be studied in order to better understand the origins of tight gas accumulation, and to predict the limits of the accumulation in areas where little drillhole information is available. The architecture of sandstone reservoirs will be studied in outcrop to predict production characteristics of similar reservoirs within the tight gas accumulation. Core and cuttings will be used to determine thermal maturities, quality of source rocks, and diagenetic histories. The authors work thus far has concentrated in the Wind River Indian Reservation in the western part of the basin. The US Geological Survey has just completed a Bureau of Indian Affairs-funded three-year project with the Shoshone and Arapaho Tribes of the Wind River Indian Reservation to study the oil and gas and coalbed methane resources of the Reservation. The Reservation project culminated in August and provided three important products: (1) a field trip to the Reservation; (2) a special session

highlighting these results at the Wyoming Geological Association Meeting in Casper Wyoming; (3) and the publication of a Wyoming Geological Association guidebook on the Wind River Basin.

5037 (DOE/METC–94/1002, pp. 258-263) **Reserves in western basins.** Caldwell, R.H. (Scotia Group, Dallas, TX (United States)); Cotton, B.W. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-91MC28130. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this project is to investigate the reserves potential of overpressured tight (OPT) gas reservoirs in three Rocky Mountain basins. These are the Greater Green River Basin (GGRB), Uinta Basin and Piceance Basin. By documenting productive characteristics in these basins and characterizing the nature of the vast gas resources in place, the reserves potential may be understood and quantified. Through this understanding, it is hoped that the oil and gas industry will be encouraged to pursue exploitation of this resource. At this point in time, the GGRB work has been completed and the final report submitted for publication. Work on the Uinta basin has just commenced and work on the Piceance basin will commence next year. Since the GGRB portion of this project has been completed, further discussion will center upon this Basin.

5038 (DOE/METC–94/1002, pp. 459-471) **Examples from the atlas of major Appalachian Basin gas plays.** Patchen, D.G. (Appalachian Oil and Natural Gas Research Consortium, Morgantown, WV (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives of this contract are to produce a printed atlas of major Appalachian basin gas plays and to compile a machine-readable database of reservoir data. The Appalachian Oil and Natural Gas Research Consortium, a partnership of the state geological surveys in Kentucky, Ohio, Pennsylvania, and West Virginia, and the departments of Geology and Petroleum and Natural Gas Engineering at West Virginia University, agrees with the need to classify gas reservoirs by geologic plays. During meetings with industry representatives, the small independents in the basin emphasized that one of their prime needs was to place each producing reservoir within a stratigraphic framework subdivided by environment of deposition to enable them to develop exploration and development strategies. The Appalachian basin is a broad geologic province that spans several states. There is no central regulatory authority, similar to the Texas Railroad Commission, acting as a source of detailed reservoir data. The general absence of major oil and gas companies in the exploration and development of the basin has resulted in many small independent operators with limited geologic staffs generating internal reports on prospective areas for drilling; these reports are often not published. Most private vendors of oil and gas well and reservoir information are generally lacking in historical data typical of mature provinces. Finally, significant exploration and development occurred prior to the establishment of statewide regulatory agencies.

5039 (DOE/METC–94/1002, pp. 472-481) **Gulf of Mexico Oil and Gas Atlas Series: Play analysis of oligocene and miocene reservoirs from Texas State offshore waters.** Finley, R.J. (Univ. of Texas, Austin, TX (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of the Offshore Northern Gulf of Mexico Oil and Gas Resource Atlas Series is to define hydrocarbon plays by integrating geologic and engineering data for oil and gas reservoirs with large-scale patterns of depositional basin fill and geologic age. The primary product of the program will be an oil and gas atlas set for the offshore northern Gulf of Mexico and a computerized geographical information system of geologic and engineering data linked to reservoir location. The oil and gas atlas for the Gulf of Mexico will provide a critically compiled, comprehensive reference that is needed to more efficiently develop reservoirs, to extend field limits, and to better assess the opportunities for intrafield exploration. The plays atlas will provide an organizational framework to aid development in mature areas and to extend exploration paradigms from mature areas into frontier areas deep below the shelf and into deep waters of the continental slope. In addition to serving as a model for exploration and education, the offshore atlas will aid resource assessment efforts of State, Federal, and private agencies by allowing for greater precision in the extrapolation of variables within and between plays. Classification and organization of reservoirs into plays have proved to be effective in previous atlases produced by the Bureau, including the Texas oil and gas atlases, the Midcontinent gas atlas, and Central and Eastern Gulf Coast gas atlas.

5040 (DOE/METC–94/1002, pp. 490-495) **Analysis of deep seismic reflection and other data from the southern Washington Cascades.** Stanley, W.D. (Geological Survey, Denver, CO (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Limited possibilities exist for new hydrocarbon exploration regimes in the Pacific Northwest. Extensive geophysical studies have been used to outline a proposed sedimentary basin hidden beneath volcanic rocks of the Cascades region of southwestern Washington. Electrical geophysical imaging using the magnetotelluric (MT) method first detected thick, electrically conductive sequences believed to represent late Cretaceous to Oligocene marine sedimentary rocks. The conductive section occurs at depths from about 1 km to 10 km in the area west of a line between Mt. Rainier and Mt. Adams, extending westward to a line between Mt. St. Helens and just west of Morton, WA. The conductive rocks reaches thicknesses as great as 10 km. The anomalous rocks appear to be very near the surface in the axis of anticlines that bring Eocene marine shales to shallow depths. Careful consideration of physical properties and the correspondence of the morphology of the units to known fold sets suggest that the high conductivities are related to lithologic/stratigraphic units rather than to variations in physical properties. The authors preference for the lithology of the anomalous section, based upon a study of regional geology and structure, is one dominated by marine shales of Eocene and older age. Other possible lithologies that have been evaluated for the conductive section include nonmarine sedimentary units of Tertiary age, highly altered volcanic flows, and pre-Tertiary metasedimentary rocks with large percentages of graphite. They refer to this anomalously conductive region as the southern Washington Cascades conductor (SWCC).

5041 (DOE/METC–94/1002, pp. 496-497) **Analysis and evaluation of gas hydrate on Alaska's North Slope.** Collett, T.S. (Geological Survey, Denver, CO (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The primary objective of this project is to assess the production characteristics and economic potential of continental gas hydrates. Because of national interest and the abundance of geologic data, this research has focused on assessing the gas hydrates within northern Alaska. This project has been designed to obtain a clear understanding of the gas hydrate resource potential in northern Alaska and to develop the extraction technology necessary to economically produce gas hydrates. This study has resulted in the discovery of an estimated 40 tcf of gas trapped as gas hydrates, or about twice the volume of conventional gas in the Prudhoe Bay field. On the North Slope, the zone in which methane hydrates may exist is really extensive beneath most of the Arctic coastal plain

and extends to depths greater than 1,000 m in the Prudhoe Bay area. Gas hydrates have been conclusively identified and tested in a Prudhoe Bay field well and are inferred to occur in a series of discrete reservoirs overlying the eastern part of the Kuparuk River field, the southern part of the Milne Point field, and the western part of the Prudhoe Bay field. Recently, multichannel seismic data from northern Alaska has revealed the first ever observed onshore gas hydrate surface simulating reflector (SSR). This prominent reflector in the Prudhoe Bay area coincident with the base of the gas hydrate stability zone is postulated to be the result of free-gas trapped stratigraphically downdip below gas-hydrate-bearing sediments. The discovery of this SSR confirms the occurrence of gas hydrate/free-gas accumulation in western Siberia from which ~70 bcf of gas has been produced from hydrates alone. The production history of the Messoyakha field has demonstrated that gas hydrates are an immediate producible source of natural gas and that production can be started and maintained by conventional methods.

5042 (DOE/METC–94/1002, pp. 498-515) **Gas hydrate detection and mapping on the US East Coast.** Dillon, W.P. (Geological Survey, Reston, VA (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Project objectives are to identify and map gas hydrate accumulations on the US eastern continental margin using remote sensing (seismic profiling) techniques and to relate these concentrations to the geological factors that control them. In order to test the remote sensing methods, gas hydrate-cemented sediments will be tested in the laboratory and an effort will be made to perform similar physical tests on natural hydrate-cemented sediments from the study area. Gas hydrate potentially may represent a future major resource of energy. Furthermore, it may influence climate change because it forms a large reservoir for methane, which is a very effective greenhouse gas; its breakdown probably is a controlling factor for sea-floor landslides; and its presence has significant effect on the acoustic velocity of sea-floor sediments.

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Refer also to citation(s) 4933, 5030

5043 (DOE/MC/26026–95/C0404) **Multistrata exploration and production study.** Hawkins, L.; Brunk, R.G.; Al-Saadoon, F.T.; Weekley, J.L. West Virginia Coll., Beckley, WV (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-89MC26026. (CONF-9410262–1: Coalbed methane utilization conference, Katowice (Poland), 5-7 Oct 1994). Order Number DE95004219. Source: OSTI; NTIS; GPO Dep.

The project objective is to verify a development strategy for high grading areas of multistrate (shallow gas sands and coalbeds) potential in southern West Virginia and test it in up to five wells. Activities for the Multistrata Project began in Fiscal Year 1993 with the placement of the three Test Wells into production full force. By turning all three wells in line October 1, 1992, gas began flowing as designed by the agreements negotiated in Fiscal Year 1992. All the parties involved began to see tangible results as the gas moved from the College's gathering lines into the systems of Ramco, Columbia, and Mountaineer Gas Companies. The gas production overall from the three Project Test Wells has been exceptional. Work is currently underway which will allow for enhanced production from the College wells. This involves installation of a two-phase, 20 hp gas operated compressor into the main sales line. The College of West Virginia gathering system will be tied directly into a system owned by another local producer and will necessitate the laying of 700 feet of additional pipeline. The compressor will be equipped to suction 1 psi and discharge at 75 psi for delivery of the College's gas into the host system.

5044 (DOE/METC–94/1002, pp. 151-171) **Fracturing Fluid Characterization Facility (FFCF).** Roegiers, J.C. (Univ. of Oklahoma, Norman, OK (United States)); Fagan, J. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FC21-92MC29077. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives of this project are: (1) Design and fabricate a large scale experimental apparatus for characterizing proppant laden fracturing fluids. (2) Investigate rheological properties and proppant transport characteristics of various fracturing fluids used for stimulating oil and gas bearing formations. (3) Develop new information for characterizing the behavior of fracturing fluids under conditions more representative of the behavior in actual fractures.

5045 (DOE/METC–94/1002, pp. 172-185) **Introduction to the GRI/DOE Field Fracturing Multi-site Project.** Middlebrook, M.L. (CER Corp., Las Vegas, NV (United States)); Warpinski, N.R.; Cleary, M.P.; Branagan, P.T. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FC21-93MC30070. Contract 5093-221-2553. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of the Field Fracturing Multi-Sites Project is to conduct field experiments and analyze data that will result in definitive determinations of hydraulic fracture dimensions using remote well and treatment well diagnostic techniques. In addition, experiments will be conducted to provide data that will resolve significant unknowns with regard to hydraulic fracture modeling, fracture fluid rheology and fracture treatment design. These experiments will be supported by a well-characterized subsurface environment, as well as surface facilities and equipment that are conducive to acquiring high-quality data. It is anticipated that the primary benefit of the project experiments will be the development and widespread commercialization of new fracture diagnostics technologies to determine fracture length, height, width and azimuth. Data resulting from these new technologies can then be used to prove and refine the 3D fracture model mechanisms. It is also anticipated that data collected and analyzed in the project will define the correct techniques for determining fracture closure pressure. The overall impact of the research will be to provide a foundation for a fracture diagnostic service industry and hydraulic fracture optimization based on measured fracture response.

5046 (DOE/METC–94/1002, pp. 186-199) **Slant hole completion test, Cozzette and paludal production testing.** Mann, R.L. (CER Corp., Las Vegas, NV (United States)); Malinowsky, M.S. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-90MC26024. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives for testing the sidetrack to the original slant hole wellbore are as follows: (1) Production test the Cozzette open-hole interval into the pipeline to determine long-term gas productivity. (2) Production test selected paludal sandstones and coals in the 60° section of the wellbore to determine long-term gas productivity. The Slant Hole Completion Test is a test well drilled to evaluate the effectiveness of directional drilling in stimulating gas productivity in tight, naturally-fractured sandstones and coals of the Mesaverde Group in the Rulison Field in northwestern Colorado, Garfield County, Colorado. Drilling operations were completed during August 1991. The well was turned to the pipeline on January 16, 1992, producing from the unstimulated Cozzette open-hole interval at a gas rate of 3.0 MMCFD with no water. This paper discusses the results of production testing in the upper Cozzette Sandstone, and stimulation and production testing in selected sandstones and coals within the paludal Mesaverde depositional environment.

5047 (DOE/METC–94/1002, pp. 267-280) **Incremental natural gas resources through infield reserve growth/secondary gas recovery.** Finley, R.J. (Univ. of Texas, Austin, TX (United States)); Levey, R.A.; Hardage, B.A. USDOE Morgantown Energy

Technology Center, WV (United States). Nov 1993. DOE Contract FG21-88MC25031. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The primary objective of the Infield Reserve Growth/Secondary Natural Gas Recovery (SGR) project is to develop, test, and verify technologies and methodologies with near- to mid-term potential for maximizing the recovery of natural gas from conventional reservoirs in known fields. Additional technical and technology transfer objectives of the SGR project include: (1) To establish how depositional and diagenetic heterogeneities in reservoirs of conventional permeability cause reservoir compartmentalization and, hence, incomplete recovery of natural gas. (2) To document examples of reserve growth occurrence and potential from fluvial and deltaic sandstones of the Texas gulf coast basin as a natural laboratory for developing concepts and testing applications to find secondary gas. (3) To demonstrate how the integration of geology, reservoir engineering, geophysics, and well log analysis/petrophysics leads to strategic recompletion and well placement opportunities to reserve growth in mature fields. (4) To transfer project results to a wide array of natural gas producers, not just as field case studies, but as conceptual models of how heterogeneities determine natural gas flow units and how to recognize the geologic and engineering clues that operators can use in cost-effective manner to identify incremental, or secondary, gas.

5048 (DOE/METC–94/1002, pp. 283-286) **Multistrata exploration and production study.** Brunk, R.G. (College of West Virginia, Beckley, WV (United States)); Walter, T.; Morgan, J.; Al-Saadoon, F.T. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-89MC26026. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this project was to develop and verify a geotechnical/geostatistical approach to find natural gas resources and to verify the process by drilling, completing, testing, and producing wells located by the process. Research conducted on the Eccles 7.5' quadrangle in Raleigh County, WV, in 1990, pinpointed several target areas. Immediate landowners, gas companies, and mineral rights owners were contacted to determine their willingness to assist the College in conducting the research. Extensive talks were held and as a result, agreements were drawn up between the College and the owners and Test Well 1 was completed in May 1991 and Test Wells 2 and 3 in November, 1991. The wells were shut in for one year thereafter while the parties involved negotiated agreements. The wells were placed on line at the close of fiscal year 1992. This paper summarizes the activities in 1993.

5049 (DOE/METC–94/1002, pp. 309-318) **CO_2/sand fracturing in low permeability reservoirs.** Mazza, R.L. (Petroleum Consulting Services, Canton, OH (United States)); Gehr, J.B. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-90MC26025. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives are: (1) To demonstrate the effectiveness of a non-damaging liquid, carbon dioxide (CO_2) in creating sand-propped hydraulic fractures in "tight" gas bearing formations within the Appalachian Basin. (2) To compare and rank the gas production responses from wells treated with liquid CO_2 with other types of treatments (shooting, water based, nitrogen, etc.).

5050 (DOE/METC–94/1002, pp. 319-333) **Evaluation of target reservoirs for horizontal drilling: Lower Glen Rose Formation, south Texas.** Muncey, G. (PrimeEnergy Corp., Stamford, CT (United States)); Drimal, C.E. Jr. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-91MC28239. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The primary objective of this project is to test the hypothesis that a horizontally drilled borehole can increase gas production sufficiently from the Lower Glen Rose Formation to provide an economic advantage over conventional vertical drilling. Additional objectives are to conduct detailed investigations of reservoir properties and completion methods.

5051 (DOE/METC–94/1002, pp. 334-341) **Horizontal drilling in shallow reservoirs.** Murray, W.F. Jr. (Belden & Blake Corp., North Canton, OH (United States)); Schrider, L.A.; McCallister, J.V.; Mazza, R.L. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-91MC28240. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives of this joint horizontal drilling effort by the US DOE and Belden & Blake in the complex, low permeability Clinton Sandstone will focus on the following objectives: (1) apply horizontal drilling technology in hard, abrasive, and tight Clinton Sandstone; (2) evaluate effects of multiple hydraulic fracturing in a low permeability horizontal wellbore; (3) assess economic viability of horizontal drilling in the Clinton and similar tight gas sands.

5052 (DOE/METC–94/1002, pp. 342-351) **Measurement-while-drilling (MWD) development for air drilling.** Harrison, W.H. (Geoscience Electronics Corp., Westlake Village, CA (United States)); Rubin, L.A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-88MC25105. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this program is to tool-harden and make commercially available an existing wireless MWD tool to reliably operate in an air, air-mist, or air-foam environment during Appalachian Basin oil and gas directional drilling operations in conjunction with downhole motors and/or (other) bottom-hole assemblies. The application of this technology is required for drilling high angle (holes) and horizontal well drilling in low-pressure, water sensitive, tight gas formations that require air, air-mist, and foam drilling fluids. The basic approach to accomplishing this objective was to modify GEC's existing electromagnetic (e-m) "CABLELESS"™ MWD tool to improve its reliability in air drilling by increasing its tolerance to higher vibration and shock levels (hardening). Another important aim of the program is to provide for continuing availability of the resultant tool for use on DOE-sponsored, and other, air-drilling programs.

5053 (DOE/METC–94/1002, pp. 352-355) **Steerable percussion air drilling system.** Bui, H.D. (Smith International Inc., Houston, TX (United States)); Oliver, M.S.; Gray, M.A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-92MC28182. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The cost-sharing contract between the US DOE and Smith International provides the funding to further develop this concept into two complete steerable percussion air drilling system prototypes, each integrated with a navigation tool (wireline steering tool), a bend sub, stabilizing devices, and to conduct laboratory and field testing necessary to prepare the system for commercial realization. Such a system would make available for the first time the ability to penetrate earthen formations by the percussion method, using compressed air as the drilling fluid, and at the same time allow the directional control and steering of the drill bit. While the drill string is not rotating (slide mode), one can orient to build angle in the desired direction at a predictable rate. This build rate can be in the range of 1-20 degrees per one hundred feet and proceeds until the desired inclination or direction has been obtained. The drill pipe is then set in rotation, nullifying the effect of the bend angle, and causes the assembly to drill straight. The sliding procedure can be repeated as often as corrections for hole's inclination or direction are needed.

5054 (DOE/METC–94/1002, pp. 381-389) **Low temperature H_2S separation using membrane reactor with redox catalyst.** Pellegrino, J.J. (National Institute of Standards and Technology, Boulder, CO (United States)); Ko, M.; Watts, L. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AI21-86MC23120. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The authors are combining a low temperature redox catalyst with an H_2S selective membrane to create a composite-catalytic-membrane-reactor (CCMR) to help reach pipeline-quality natural gas H_2S levels of below 4 ppm. The goal of this program is to identify the apparent kinetic and mass transfer parameters for the CCMR. Using these kinetic and mass transfer parameters a preliminary process design can be made to ascertain the potential of this technology for replacement of conventional amine scrubbing and Claus sulfur recovery processes. In pursuit of this goal the project contains the following activities: Construction of reactor and mass transfer equipment suitable for accurate measurements and safe handling of pure H_2S. Initial proof-of-concept experiments with a prototype CCMR. Obtain literature data and develop thermodynamic models for multicomponent natural gas components' solubility in electrolyte solutions. Make physical and chemical measurements on the catalyst. Obtain kinetic data using a 3-phase slurry reactor. Obtain kinetic data for a catalytic membrane under varying mass transfer conditions. Develop mathematical models to guide experimental work and for interpretation of results. Optimize the permselective membrane part of the CCMR using commercially available materials. Further proof-of-concept experiments with an optimized CCMR. Develop preliminary process design and economic analysis for the use of a CCMR in gas cleanup.

5055 (DOE/METC–94/1002, pp. 390-408) **Upgrading natural gas by means of highly performing polyimide membranes.** Stern, S.A. (Syracuse Univ., NY (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FG21-91MC28072. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of the present research project is to assess the potential usefulness of membrane separation processes for the removal of acid gases (CO_2 and H_2S) and H_2O vapor from low-quality natural gas.

5056 (DOE/METC–94/1002, pp. 409-415) **Low-quality natural gas sulfur removal/recovery with membranes.** Lokhandwala, K.A. (Membrane Technology and Research Inc., Menlo Park, CA (United States)); Amo, K.A.; Baker, R.W.; Pinnau, I.; Toy, L.; Wijmans, J.G. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-92MC28133. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The main objective of this program is to develop a membrane process for the separation of hydrogen sulfide and other impurities (carbon dioxide and water vapor) from low-quality natural gas. The overall program involves development and parametric testing of appropriate membrane materials in the form of thin-film composite membranes. These membranes will then be made on a larger scale and incorporated into modules which will be tested first in the laboratory, and then at different field sites. A technical and economic analysis of the membrane process will then be performed and compared with existing processes.

5057 (DOE/METC–94/1002, pp. 416-425) **Low-quality natural gas sulfur removal/recovery.** Siwajek, L.A. (CNG Research Co., Pittsburgh, PA (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-92MC29470. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objectives are: (1) Develop conceptual process designs and economics for large scale (200 MMSCFD) treatments of low quality natural gas having high carbon dioxide content (>10%) and hydrogen sulfide. (2) Construct an experimental research plan for the Optional Program.

5058 (DOE/METC–94/1002, pp. 426-431) **Application of rotating contactor to natural gas processing.** Semrau, J.T. (Institute of Gas Technology, Chicago, IL (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FC21-92MC28178. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of the US DOE and Gas Research Institute (GRI) program entitled "Evaluation of High-Efficiency Gas-Liquid Contactors for Natural Gas Processing" is to evaluate the potential of rotating gas-liquid contactors for natural gas processing by expanding the currently available database. This expansion is leading to commercial demonstration of this technology to environments representative of those typically encountered in the natural gas processing industry. Operational and reliability concerns will be addressed while generating pertinent engineering data relating to the mass-transfer process.

5059 (DOE/METC–94/1002, pp. 435) **Site selection and evaluation of a horizontal well in the Clinton Sandstone.** Mroz, T.H.; Schuller, W.A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

An integrated geologic and reservoir study was completed as part of the site evaluation to locate a horizontal well in the Clinton Sandstone in Mahoning County, Ohio. The effort is part of a study to evaluate site selection criteria, drilling and completion technologies and fracture diagnostics in low permeability reservoirs. The information presently includes data from a number of sources; core and reservoir analysis data from a GRI sponsored vertical well, geologic and well data from Belden & Blake Inc., and the integrated two dimensional and three dimensional geological model interpretation data. The integrated information is used as input for predicting vertical versus horizontal well production and economics. The integrated methodologies show the criteria needed to design and drill a horizontal well effectively in the Clinton Sandstone of eastern Ohio.

5060 (DOE/METC–94/1002, pp. 445) **Computer modeling of geologic strata in the multi-strata project area (Beckley).** Mroz, T.H.; Byrer, C.W.; Evans, D.M.; Saadoon, F.A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The Multistrata Test is a contract effort with the College of West Virginia and BDM Corp. as a subcontractor on the technical aspects of the effort. The study was initiated to show independent coal operators and gas companies the potential to develop the total energy resources in a given area. This presentation covers the review of the geologic setting and well completions of the three wells drilled west of Beckley, West Virginia. The geologic setting is presented by BDM Corp. in their final report. The well locations picked lie on the west limb of a north south structurally high block which is controlled by basement faults. The area immediately to the west is a structurally complex faulted low block and is mined at the Beckley coal horizon. The mine maps show a highly faulted area with some of the faulting controlling deposition of the coals. The wells are located on the limb and are completed in the Beckley and Pocahontas coals, the Ravencliff sandstone, and the Big Lime. A review of the geologic setting was done to determine if water and gas saturations could be explained by the location of the wells to the surrounding geologic structures. The structure does not explain the

total gas and water distribution in the productive formations. The well completions were also evaluated to determine if the production would be enhanced by limiting the water production. The three wells show that water is the main problem in limiting gas flow.

5061 (DOE/METC–94/1002, pp. 446-458) **Inorganic polymer-derived ceramic membranes.** Brinker, C.J. (Sandia National Labs., Albuquerque, NM (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Polymeric silica sols were used to prepare membranes on commercial γ-Al_2O_3 supports. Aging of the silica sols was shown to be effective to form discrete membrane layers. He/N_2 selectivity factors exceeding ideal Knudsen values were observed when the sols were prepared under conditions in which the condensation rate was minimized. The authors propose that the average pore size of the membrane depends on the balance of capillary pressure and modulus during membrane deposition and that the breadth of the pore size distribution might be influenced by the extent of condensation accompanying membrane deposition. The use of organic templates may allow independent control of pore size, pore shape, and pore volume.

5062 (DOE/METC–94/1002, pp. 530-543) **Greater Green River Basin well-site selection.** Frohne, K.H.; Boswell, R. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Recent estimates of the natural gas resources of Cretaceous low-permeability reservoirs of the Greater Green River basin indicate that as much as 5,000 trillion cubic feet (Tcf) of gas may be in place (Law and others). Of this total, Law and others attributed approximately 80 percent to the Upper Cretaceous Mesaverde Group and Lewis Shale. Unfortunately, present economic conditions render the drilling of many vertical wells unprofitable. Consequently, a three-well demonstration program, jointly sponsored by the US DOE/METC and the Gas Research Institute, was designed to test the profitability of this resource using state-of-the-art directional drilling and completion techniques. DOE/METC studied the geologic and engineering characteristics of "tight" gas reservoirs in the eastern portion of the Greater Green River basin in order to identify specific locations that displayed the greatest potential for a successful field demonstration.

0304 Products and By-Products

Refer also to citation(s) 5543

5063 (DOE/METC–94/1002, pp. 99-101) **Overview of PETC's Gas-to-Liquids Program.** Stiegel, G.J. (Pittsburgh Energy Technology Center, PA (United States)); Bose, A.C.; Srivastava, R.D. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The overall goal of the Gas-to-Liquids Program at the US DOE's Pittsburgh Energy Technology Center (PETC) is to develop technologies for the production of hydrocarbon fuels and value-added chemicals from light alkane gases. This research effort has been initiated to develop new or significant innovative improvements over state-of-the-art technologies for the conversion of these gases to marketable fuels and chemicals. The program is accomplished through staged development from laboratory scale through proof-of-concept scale. Maximum industrial involvement is sought in this program.

5064 (DOE/METC–94/1002, pp. 102-107) **Direct conversion of methane to methanol in a non-isothermal catalytic membrane reactor.** Falconer, J.L. (Univ. of Colorado, Boulder, CO (United States)); Noble, R.D. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FG21-90MC27115. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The direct partial oxidation of CH_4 to CH_3OH has been studied in a non-permselective, non-isothermal catalytic membrane reactor system. A cooling tube introduced coaxially inside a tubular membrane reactor quenches the product stream rapidly so that further oxidation of CH_3OH is inhibited. Selectivity for CH_3OH formation is significantly higher with quenching than in the experiments without quenching. For CH_4 conversion of 4% to 7%, CH_3OH selectivity is 40% to 50% with quenching and 25% to 35% without quenching.

5065 (DOE/METC–94/1002, pp. 108-120) **Catalytic conversion of light alkanes–research and proof-of-concept stages.** USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FC21-90MC26029. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this program is (1) to find new materials which are able to catalyze the direct reaction of light alkanes (methane, ethane, propane, butanes) with molecular oxygen to form alcohols and (2) to develop practical processes for the direct oxidative conversion of natural gas and its C_1-C_4 components producing high performance alcohol-rich liquid oxygenates for use both as alternative transportation fuels and as environmentally superior reformulated gasolines.

5066 (DOE/METC–94/1002, pp. 121-137) **Selective methane oxidation over promoted oxide catalysts.** Klier, K. (Lehigh Univ., Bethlehem, PA (United States)); Herman, R.G. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FG21-92MC29228. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this research is to selectively oxidize methane to C_2 hydrocarbons and to oxygenates, in particular formaldehyde and methanol, in high space time yields under milder reaction conditions than heretofore employed over industrially practical catalysts. In particular, air, carbon dioxide, or oxygen, rather than nitrous oxide, is being used as the oxidizing gas in a continuous flow reactor system and a wide range of reaction conditions, e.g., temperature, pressure, and gas hourly space velocity, is being explored to maximize the space time yields of the desired products. All of the investigated processes are catalytic and aimed at minimizing gas phase oxidation reactions.

5067 (DOE/METC–94/1002, pp. 138-147) **Steady-state and transient catalytic oxidation and coupling of methane.** Heinemann, H. (Lawrence Berkeley Lab., CA (United States)); Iglesia, E.; Perry, D.L. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC03-76SF00098. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Four papers have been published on the mechanisms and site requirements for the oxidative coupling of methane to ethane and ethylene and on the synthesis of thin catalytic films during fiscal 1993. These publications also describe a unique inhibiting effect of water on the rate of undesired full oxidation pathways during oxidative coupling. Five quarterly reports have been written and submitted during the covered period. These findings and recently reported models of surface and gas phase reactions of methane suggest the use of membrane reactors and of cyclic methane decomposition schemes in order to avoid deleterious full oxidation reactions and to increase C_2 yields above 25%. In fiscal 1994, the authors will proceed with the testing of proton-conducting membranes that they have recently fabricated. They will also continue

their emerging effort in cyclic decomposition of methane and scavenging of fragments on supported metal catalysts.

5068 (DOE/METC–94/1002, pp. 482-489) **The synthesis and characterization of new iron coordination complexes utilizing an asymmetric coordinating chelate ligand.** Watkins, B.E. (Lawrence Livermore National Lab., CA (United States)); Satcher, J.E. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The authors are investigating the structure/activity relationships of the bacterial enzyme, methane monooxygenase, which catalyzes the specific oxidation of methane to methanol. They then utilize this information to design and synthesize inorganic coordination complexes that mimic the function of the native enzyme but are more robust and have higher catalytic site density. They envision these catalysts to be useful in process catalytic reactors in the conversion of methane in natural gas to liquid methanol.

5069 (DOE/METC–94/1002, pp. 517-520) **Feasibility study to evaluate plasma quench process for natural gas conversion applications.** Kong, P.C. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Detering, B.A. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. Contract AB05-30150. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The objective of this program was to conduct a feasibility study on a new process, called the plasma quench process, for the conversion of methane to acetylene. FY-1993 efforts were focused on determining the economic viability of this process using bench scale experimental data previously generated.

5070 (NEI-NO–459) **Hydrogenation of CO on supported cobalt catalysts studied by in situ Fourier transform infrared (FTIR) spectroscopy.** Fredriksen, G.R. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. Dec 1993. 319p. Order Number DE95723910. Source: OSTI; NTIS.

Hydrogenation of CO over silica and alumina supported cobalt catalysts has been investigated by the use of different experimental techniques; temperatures programmed reduction, in situ infrared spectroscopy, gravimetry and measurements of activity and selectivity. Temperature Programmed Reduction (TPR) was used to characterize uncalcined silica and alumina supported cobalt catalysts with different metal loading, 0.82% and 4.7% Co/SiO_2 together with 1% and 4.6% $Co/\gamma\text{-}Al_2O_3$. In addition to reduction peaks attributed to the reductive decomposition of cobalt nitrate (the metal precursor), TPR-profiles of all the catalysts except 1% $Co/\gamma\text{-}Al_2O_3$ featured peaks which have been assigned to the reduction of cobalt oxide, Co_3O_4. The lack of the cobalt oxide reduction peak for 1% $Co/\gamma\text{-}Al_2O_3$ has been interpreted as being a result of cobalt located in interstices of the alumina lattice, forming a cobalt aluminate spinel phase. The total extent of reduction of the catalysts increased with increasing cobalt loading. A higher degree of reduction for the silica supported catalysts compared to the alumina supported cobalt catalysts was found. CO hydrogenation on silica supported cobalt catalysts studied by in situ infrared spectroscopy revealed absorption bands characteristic of linearly absorbed CO on metallic cobalt. The constant frequency (2068 ± 4 cm^{-1}) of this band at different reaction conditions ($H_2/CO=2$), $P_{Tot}=2.5$, 6 or 11 bar, T=473K has been discussed in terms of a high local coverage of adsorbed CO. CO hydrogenation over 1% $Co/\gamma\text{-}Al_2O_3$ did not reveal absorption bands attributable to molecularly absorbed CO. Ultraviolet-visible spectroscopy (UV-VIS) diffuse reflectance and TPR-measurements indicated that cobalt was located in the alumina lattice, occupying tetrahedral lattice sites, hence being inaccessible for adsorption of CO. 237 refs., 107 figs., 26 tabs.

0305 Health and Safety

5071 (NUTEK-NGAS–94-3) **Natural gas - Safety levels - Risk analysis.** Andersson, A. (Department of Fire Safety Engineering, Lund University, Lund (Sweden)); Andersson, P.; Holmstedt, G.; Saerdqvist, S. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Jun 1994. 67p. (In Swedish). Project NUTEK-656-116. (LUTVDG-TVBB–3073). Order Number DE95723993. Source: OSTI; NTIS.

This report comprise a review of legislation, control and education concerning distribution, and industrial use of natural gas in Sweden and abroad, as well as a discussion regarding risks to the society. Also described is a retrospective examination of statistical data covering accidents and incidents with natural gas, and a comparison with other risks. The report also treats calculation of the consequences of natural gas releases to the atmosphere. 20 refs, 19 figs

0306 Economic, Industrial, and Business Aspects

Refer also to citation(s) 5016, 5017, 5019, 6016

5072 (CONF-9403188–, pp. 167-174) **Latest situation around natural gas in Japan.** Akiyama, Y. (Tokyo Gas Co. Ltd., Tokyo (Japan)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy Consultation, Mr.Akiyama, Vice President of Tokyo Gas Co., Ltd. lectured on the trend of supply and demand for natural gas, the development of new LNG projects, and deregulation of town gas business in Japan. The import of LNG to Japan is as large as about 39 million tons per year, accounting for about 11% of the total primary energy supply in Japan. Town gas is about 10 million tons. LNG has been used for 70% of the total city gas in Japan. According to the Japanese Government's 'long-term energy supply/demand perspective', the demand for LNG will be 43 million tons by 2000. This demand will be fulfilled by increasing the output of the existing projects and supplying from new projects in Indonesia and Malaysia. Recently, oil companies in Japan have been more interested in LNG projects, showing the intention to handle from exploitation to operation. The Japan Petroleum Public Corporation is examining the possibility of direct investment. 3 tabs.

5073 (CONF-9403188–, pp. 175-178) **Natural gas (U.S. outlook).** Wilkinson, P. (American Gas Association, (United States)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy Consultation, Mr. Wilkinson from the American Gas Association lectured on the future of the natural gas market in the U.S.A. The gas market of future may be greatly affected by the environmental policy, energy policy, and restructuring of the gas industry. For the environmental policy, the Clean Air Act will be effected, focusing on reduction in CFC and CO2 levels. This will give higher priority to natural gas. In addition, the energy-related acts that have been enacted will also be effected, which may probably benefit the gas market. Clean and efficient gas application technologies have been developed, bringing about a bright future for the natural gas car, gas cooling, gas power generation, and others. In addition, restructuring of the gas industry itself may increase flexibility of the gas industry, making mutual cooperation easier and meeting customers' demands more completely.

5074 (ESTSC–000770IBMPC00) **RAMSGAS. World Natural Gas Model.** Reister, D.B. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 13 Dec 1986. Sponsored by USDOE, Washington, DC (United States). (NESC–9524). Source: ESTSC.

Description: IBM PC; MS-DOS; LOTUS 1-2-3; 1 5.25 Diskette. The proprietary Lotus Development Corporation Lotus 1-2-3 software is required.

RAMSGAS, the Research and Development Analysis Modeling System World Natural Gas Model, was developed to support planning of unconventional gaseoues fuels research and development. The model is a scenario analysis tool that can simulate the penetration of unconventional gas into world markets for oil and gas. Given a set of parameter values, the model estimates the natural gas supply and demand for the world for the period from 1980 to 2030. RAMSGAS is based on a supply/demand framwork and also accounts for the non-renewable nature of gas resources. The model has three fundamental components: a demand module, a wellhead production cost module, and a supply/demand interface module. The demand for gas is a product of total demand for oil and gas in each of 9 demand regions and the gas share. Demand for oil and gas is forecast from the base year of 1980 through 2030 for each demand region, based on energy growth rates and price-induced conservation. For each of 11 conventional and 19 unconventional gas supply regions, wellhead production costs are calculated. To these are added transportation and distribution costs estimates associated with moving gas from the supply region to each of the demand regions and any economic rents. Based on a weighted average of these costs and the world price of oil, fuel shares for gas and oil are computed for each demand region. The gas demand is the gas fuel share multiplied by the total demand for oil plus gas. This demand is then met from the available supply regions in inverse proportion to the cost of gas from each region. The user has almost complete control over the cost estimates for each unconventional gas source in each year and thus can compare contributions from unconventional resources under different cost/price/demand scenarios.

0307 Waste Management

Refer also to citation(s) 5054, 5055, 5056, 5057, 6149

5075 (DOE/METC–94/1002, pp. 287-298) **Process for coalbed brine disposal.** Tait, J.H. (Aquatech Services Inc., Fair Oaks, CA (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FG03-91ER81105. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

This paper describes a brine disposal process that converts the brine stream of a coalbed gas producing site, or of a coal mine, into clean water for agricultural and other use, combustion products and water vapor that can be released into the atmosphere and dry solids that can be recycled for industrial consumption. The process uses a reverse osmosis unit, a submerged combustion evaporator and a pulse combustion dryer. In addition, pretreatment facilities such as filters, pH control and antiscaling units are used upstream of the reverse osmosis unit. A successful pilot operation was completed for brine disposal from a New Mexico coalbed gas producing site in the San Juan Basin. A major consideration in the process is the pretreatment of the brine feedstream to prevent fouling of the membranes of the reverse osmosis unit and to separate from the brine stream hazardous metals and other constituents that may make the permeate from the reverse osmosis unit unsuitable for agricultural or other use. Pretreatment methods and solubilities of the salts in the brine as it flows through the reverse osmosis unit are determined prior to operations using a speciation-solubility computer model that computes a thermodynamic model of the aqueous solution using an extensive thermodynamic data base.

0308 Environmental Aspects

Refer also to citation(s) 5076

0310 Legislation and Regulations

Refer also to citation(s) 5073

5076 (DOE/METC–94/1002, pp. 94-95) **Summary-gas related environmental issues.** Ham, J. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The mission of the Environmental/Regulatory Impact Program is to reduce inefficient regulations that impede market operations; promote regulations based on improved scientific information affecting all areas of the gas system; and ensure low cost environmental technology to industry. Public and regulatory bodies continue to press for more stringent environmental regulations in all energy sectors. Regulations are rapidly becoming more restrictive not only in the levels of pollutants allowed, but also in the number of pollutants regulated. Some environmental statutes require protection of human health and the environment without consideration of potential economic or energy impacts. There is concern within the exploration and production sectors that increasingly stringent environmental regulations will significantly hinder gas production due to higher compliance costs, without any measurable environmental benefits. This concern will diminish recovery of gas reserves.

0320 Transport, Handling, and Storage

5077 (DOE/METC–94/1002, pp. 516) **Methodology for optimizing the development and operation of gas storage fields.** Mercer, J.C.; Ammer, J.R. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The Morgantown Energy Technology Center is pursuing the development of a methodology that uses geologic/reservoir modeling for optimizing the development and operation of gas storage fields. The methodology will result in defining how to provide a good geologic description of the reservoir, determine what type and how much data is needed to accurately model the field, maximize field/reservoir deliverability, minimize base gas requirements, and minimize field development costs.

5078 (ETDE/DE-mf–95733377) **The effect of bacteria reducing sulphates on cathodic corrosion protection. Final project report.** Ruhrgas AG, Essen (Germany). 1991. 74p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 11F422A. Order Number DE95733377. Source: OSTI; NTIS (US Sales Only).

The aim of the research project is to obtain a better understanding of the corrosion processes occurring on the surface of steel, both from the microbiological and the corrosion chemistry side, in order to be able to derive measures by which corrosion is reduced to a technically negligible value by bacteria reducing sulphates. (orig.)

5079 (ETDE/DE-mf–95733378) **The effect of bacteria reducing sulphates on cathodic corrosion protection. Final report.** Ruhrgas AG, Essen (Germany). 1991. 109p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 11F422A. Order Number DE95733378. Source: OSTI; NTIS (US Sales Only).

The aim of the research project is to obtain a better understanding of the corrosion processes occurring in the surface of steel, both from the microbiological and the corrosion chemistry side, in order to be able to derive measures by which corrosion is reduced to a technically negligible value by bacteria reducing sulphates. The individual main points were: 1. Determining the potential criterion for cathodic corrosion protection in the presence of bacteria reducing sulphates. 2. Determining any existing danger due to hydrogen-induced corrosion of pipeline steel with very negative setting of the cathodic corrosion protection. 3. Examination of the cause of corrosion damage, with bacteria reducing sulphates: (a) with the galvanic element steel in anaerobic conditions/steel with

aerobic conditions, (b) with the galvanic element steel/iron sulphide; 4. Investigations of the effect of bacteria reducing sulphates on the electrochemical behaviour of a steel electrode (surrounding fault position). (orig.)

5080 (SAND–94-1432) **Triaxial creep measurements on rock salt from the Jennings dome, Louisiana, borehole LA-1, core #8.** Wawersik, W.R.; Zimmerer, D.J. Sandia National Labs., Albuquerque, NM (United States). May 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94018514. Source: OSTI; NTIS; GPO Dep.

Tejas Power Company requested that facilities in the Rock Mechanics Laboratory at Sandia National Laboratories be used to assess the time-dependent properties of rock salt from the Jennings dome in Acadia Parish, Louisiana. Nominally 2.5-inch diameter slat core from borehole LA-1, core 8 (depth 3924.8 to 3837.8 ft; 1196.8–1197.1 m) was provided to accomplish two tasks: (1) Using the smallest possible number of experiments, evaluate the tendency of Jennings salt to undergo time-dependent deformation (creep) under constant applied stresses, and compare the creep of Jennings salt with creep data for rock salt from other locations. (2) Assess the applicability of published laboratory-derived creep properties for rock salt from several bedded and domal sites in finite element analyses concerning the design of new gas storage caverns in the Jennings dome. The characterization of Jennings salt followed the same strategy that was applied in earlier laboratory experiments on core from the Moss Bluff dome near Houston, Texas. This report summarizes the relevant details of five creep experiments on a sample from depth 3927.5 ft, the results obtained, and how these results compared with laboratory creep measurements gathered on rock salt from other locations including the West Hackberry, Bryan Mound and Moss Bluff domes. The report also considers the estimates of specific creep parameters commonly used in numerical engineering design analyses.

0330 Properties and Composition

Refer also to citation(s) 6149

0340 Combustion

Refer also to citation(s) 4969, 4978, 6080

5081 (LUTMDN-TMVK–5239) **NOx-formation when adding hydrogen to natural gas.** Bergstroem, C.; Sundstroem, T. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Oct 1994. 40p. (In Swedish). Order Number DE95723986. Source: OSTI; NTIS.

The aim of this study was to find out if it is possible to reduce the emission of nitrogen oxides in natural gas combustion by adding hydrogen. The work was limited to small burners and additions up to 15 per cent. A fan burner and a fiber burner were used for the tests. In the measurements excess air, nitrogen oxides, carbon monoxide and (for the fan burner) flue gas temperature were recorded. For the fan burner an increase of nitrogen oxides of up to 30 per cent was measured, and for the fiber burner no significant changes were noted. 12 refs, 24 figs, 4 tabs

04 OIL SHALES AND TAR SANDS

0404 Oil Production, Recovery, and Refining

Refer also to citation(s) 5087

5082 (CONF-9405258–, pp. 299-303) **Dynamic reservoir imaging by electrical method in steam stimulation process. Results observed in the field.** Tamagawa, T. (Japan Petroleum Exploration Co. Ltd., Tokyo (Japan)); Miyairi, M.; Ushijima, K.; Hirata, T. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper introduces an example (in Canada) of having observed the change in both spontaneous potential (SP) and apparent resistivity in the steam stimulation. Oilsand strata existing at the depth of about 300m were stimulated with steam at the flow rate of 100 to 200m^3/day from six wells. In a domain of about 0.47km^2 surrounding the stimulation area, P1 potential electrodes were installed at 67 spots, while P2 potential ones were done about 1km distantly from those spots. Then, the potential differential between both P1 and P2 electrodes were continuously measured for a period of about 2.5 months before, during and after the steam stimulation by making a DC current flow consecutively to the casing of observation well located at the central part. The result was as follows: the change in SP was very stable before the steam stimulation. Immediately after its start, observed was a pulselike change in SP judged attributable to the fluid flow potential. With the passing of time after its start, the SP rose gradually and the apparent resistivity also changed significantly. 3 refs., 10 figs.

5083 (DOE/METC–94/1002, pp. 17-27) **Status of LLNL hot-recycled-solid oil shale retort.** Cena, R.J. (Lawrence Livermore National Lab., CA (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract W-7405-ENG-48. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The oil shale deposits in the Western US represent a massive liquid fuel resource, with over 600 billion barrels of recoverable deposits in the Piceance Basin alone. LLNL's objective, together with their CRADA partners, is to demonstrate advanced technology that could lead to an economic and environmentally acceptable commercialization of oil shale. They have investigated the technical and economic barriers facing the introduction of an oil shale industry and have chosen Hot-Recycled-Solid (HRS) oil shale retorting as the primary advanced technology of interest. They are investigating this approach through fundamental research, operation of a 4 tonne-per-day HRS pilot plant and development of an Oil Shale Process (OSP) mathematical model. Over the last three years, from June 1991 to June 1993, they completed a series of runs using the 4-TPD pilot plant to demonstrate the technical feasibility of the HRS process and answer key scale-up questions. With their CRADA partners, they seek to further develop the HRS technology, maintain and enhance the knowledge base gained over the past two decades through research and development by Government and industry and determine the follow on steps needed to advance the technology towards commercialization.

5084 (DOE/METC–94/1002, pp. 37-47) **Shale oil value enhancement research–separation characterization of shale oil.** Bunger, J.W. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract AC21-93MC29240. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The overall objective is to develop a new technology for manufacturing valuable marketable products from shale oil. Phase I objectives are to identify desirable components in shale oil, develop separations techniques for those components, identify market needs and to identify plausible products manufacturable from raw shale oil to meet those needs. Another objective is to conduct preliminary process modeling and economic analysis of selected process sequences and product slates, including an estimation of prices, costs and profitability. The end objective of Phase I is to propose technically and economically attractive separations and conversion processes for small-scale piloting in the optional Phase II. Optional Phase II activities include the pilot-scale test of the Shale Oil Native Products Extraction (SO-NPX) technology and to produce specification products. Specific objectives are to develop the engineering data on separations processing, particularly those in which mixtures behave non-ideally, and to develop the conversion processes for finishing the separations concentrates into

specification products. The desired process scenarios will be developed and economic analysis will be performed on the process scenarios. As a result of the process simulation and economic analysis tasks, a product manufacture and test marketing program shall be recommended for the optional Phase III. Optional Phase III activities are to manufacture specification products and to test market those products in order to ensure market acceptability. The activities involve the assembling of the technical, market and economic data needed for venture evaluation. The end objective is to develop the private sector interest to carry this technology forward toward commercialization.

5085 (DOE/METC–94/1002, pp. 48-58) **Oil and gas yields from Devonian oil shale in the 50-lb/hr KENTORT II process demonstration unit: Initial results.** Carter, S.D. (Univ. of Kentucky, Lexington, KY (United States)); Taulbee, D.N. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FC21-90MC27286. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The broad objective of this program is to perform the research necessary to design, construct, test, and optimize the KENTORT II process at the 50-lb/hr scale. Many of the authors objectives have already been realized. The retort has been successfully constructed and the shakedown phase is essentially complete. In addition, much of the coking and cracking kinetics experiments have been completed which will provide important information for the operation of the retort. They are now entering the testing phase for the retort which has the following objectives: (1) Determine any relationships between the retorting conditions and the yield and characteristics of the products, and compare the results to those from the bench-scale shale oil cracking and coking experiments. (2) Study and develop alternative applications for the products from the KENTORT II process. In particular, asphalt performance tests will be conducted on the heavy fraction of oil produced during the testing phase.

5086 (DOE/METC–94/1002, pp. 61-68) **University of Utah Oil Sand Research and Development Program.** Oblad, A.G.; Bunger, J.W.; Dahlstrom, D.A.; Deo, M.D.; Fletcher, J.V.; Hanson, F.V.; Miller, J.D.; Seader, J.D. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract FC21-89MC26268. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

An overview of the Oil Sand Research and Development Program at the Univ. of Utah will be presented. It will include resource characterization of the Uinta Basin oil sand deposits and bitumens and bitumen-derived liquid recovery and upgrading technology and product utilization. The characterization studies will include the Whiterocks and Asphalt Ridge oil sands. The discussion of recovery and upgrading technologies will include aqueous separation, thermal recovery processes; solvent extraction, and thermal and catalytic upgrading of bitumen and bitumen-derived heavy oils. Product evaluation studies will include jet fuels, diesel fuel, asphalt and specialty chemicals. Plans for the future of the project will be discussed.

0405 Properties and Composition

5087 (DOE/METC–94/1002, pp. 28-36) **Shale oil from the LLNL pilot retort: Metal ions as markers for water and dust.** Cena, R.J. (Lawrence Livermore National Lab., CA (United States)). USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. DOE Contract W-7405-ENG-48. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

A metal ion found primarily in one of the three phases (oil, water, or dust) can serve as a marker for that phase. Emulsified water contains most of the magnesium detected in a shale oil. Extraction with saturated salt solution removes most of that Mg. The Mg content of retort water and the percentage of water in the oil (by ASTM D-4006) provides a good estimate of an oil's Mg content. Mineral matter elements with poorly water soluble carbonates (or oxides) at pH 8 (calcium, for example) serve as markers for dust. When the water is separated from the main and light oil fractions before adding the heavy fraction containing dust, a much drier oil can be obtained. However, when done in this way, a powder containing Ca and Si remains in the oil; it cannot be completely removed even by filtering through a 0.24-μ frit. Iron, and certain other transition metal ions, is quite oil soluble. Extraction with dilute nitric acid to remove basic amines reduces the Fe content of shale oil. Unlike carboxylate-complexed metal ions in crude oils, the iron in shale oil does not extract efficiently into an aqueous EDTA solution (pH 5.9). Distillation of shale oil leaves most of the iron and other metals behind in the vacuum residuum. Shale oil corrodes the hottest condenser's steel interior; this is the chief source of iron in the oil.

0406 Products and By-Products

Refer also to citation(s) 5084

0408 Economic, Industrial, and Business Aspects

Refer also to citation(s) 5083

0440 Combustion

Refer also to citation(s) 5538

05 NUCLEAR FUELS

Refer also to citation(s) 5862

0504 Feed Processing

5088 (HW–31767) **Hot semiworks Redox studies.** Evans, T.F.; Tomlinson, R.E. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 27 Jan 1954. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95003377. Source: OSTI; NTIS; GPO Dep.

The separations Hot Semiworks at the Hanford Atomic Products Operation was built in order to: (1) develop optimum conditions for the economic operation of the Redox and TBP plants, (2) procure engineering design data which would allow the specification of process equipment required for new processes such as Purex, (3) provide facilities for the study of future process and engineering problems on a semiworks scale employing radioactive process solutions, and (4) provide facilities for immediate trouble shooting for urgent separations plant problems. The initial operation of this facility was designed to develop conditions for the economic operation of the Redox Plant. These studies, covering a period from November, 1952 to October, 1953, are described in this report. The Redox process is used at Hanford for the separation of uranium and plutonium from fission products and from each other. The basis of the process is the preferential extraction of uranium and plutonium nitrates from an aqueous phase of high salting strength into an organic solvent (methyl isobutyl ketone) to effect the separation from fission products. This operation is conducted continuously in columns, packed with Raschig rings, through which the phases are passed counter-currently. Uranium and plutonium are separated by converting the plutonium to a lower valence state, in which form it is preferentially extracted back into an aqueous phase of high salting strength in a second column. Uranium is then returned to an aqueous phase of low salting strength in a third column. The products are further decontaminated in similar additional cycles. A detailed description of the process is given in the Redox Technical Manual.

5089 (WSRC-TR–94-0525) **Radiolysis gases from nitric acid solutions containing HSA and HAN.** Smith, J.R. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Oct 1994. 24p. Sponsored by USDOE, Washington, DC (United

States). DOE Contract AC09-89SR18035. Order Number DE95004409. Source: OSTI; NTIS; GPO Dep.

The concentration of hydrogen (H_2) in the radiolytically produced off-gas from 2.76-4.25M HNO_3/PU solutions has been found to be greatly reduced in the presence of sulfamic acid (HSA) and hydroxylamine nitrate (HAN). The H_2 concentration ([H_2]) is reduced from 35 percent to about 4 percent by dilution caused from an increase in the production rates of nitrogen (N_2), nitrous oxide (N_2O), and oxygen (O_2) gases. The generation rate of H_2 was not affected by HSA or HAN giving a measured radiolytic yield, G(H_2), value of 0.201 molecules/100 eV for 2.765M NO_3^- solution (a value of 0.213 is predicted from previous data). The G(H_2) values are dependent on the solution nitrate concentration ([NO_3^-]). The generation rates of N_2, N_2O, and O_2 are not dependent on the [NO_3^-] in this narrow range, but are dependent on the presence of HSA and the concentration of HAN. The percentage [H_2] for the 2.5 to 3.0M NO_3^- range expected in the off- from the FB-Line Pu^{+3} Hold Tanks is conservatively estimated to be about 3.5 to 4.5 % for Pu + 3 solutions initially containing 0.023M HAN/0.165M HSA. The upper limit [H_2] may actually be about 4.1 % (4.3 % at 90 % confidence limits) but more "initial" off-gas rate data is needed at about 2.9M [NO_3^-] in Pu^{+3} solution for verification. Addition of ascorbic acid had no effect on the off-gas rate of Pu^{+3} solutions containing HSA and NO_3^- concentrations higher than those expected in the hold tanks. The maximum "hold time" for 50 grams/liter Pu^{+3}/0.165M HSA/0.023M HAN/2.5-3.0M HNO_3 solution is 20.3±2.1 days. After this time the HSA initially present will become exhausted and the [H_2] will increase to 35 %. This hold time may be longer in [NO_3^-] < 3.0M, but again more study is needed.

0507 Fuels Production and Properties

Refer also to citation(s) 5846, 5864, 5867

5090 (HAN–85392) **Problems contributing to reduced neptunium shipments FY-1963.** General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 19 Jun 1963. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94015116. Source: OSTI; NTIS; GPO Dep.

Short communication. NEPTUNIUM/losses; PUREX PROCESS; NEPTUNIUM; LOSSES; SEPARATION EQUIPMENT; PROCESS CONTROL

5091 (RL-NRD–163) **N-Fuels Engineering programs: CY-1965.** Nickolaus, J.W. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 8 Jan 1965. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94015106. Source: OSTI; NTIS; GPO Dep.

Programs undertaken by N-Fuels Engineering should be designed to achieve the following general objectives; (1) maintain and/or improve fuel element quality level necessary to assure satisfactory reactor performance; (2) develop the fuel fabrication technology required to support the development and testing of new fuel designs; (3) reduce fuel manufacturing costs to achieve projected operated cost targets; (4) reduce the uranium metal costs charged to N-Reactor. Further, these programs must be integrated to provide maximum support to identifiable Section and Department goals. The specific goals for CY-65 are: (1) development technology necessary to support conversion to co-product operation early in CY-66; (2) conduct a program of uranium fabrication development to improve fuel element quality and reduce uranium costs; (3) improve fuel element quality, manufacturing yields, and conversion costs for the current production fuel design; (4) develop fuels capable of extended exposure and/or higher power level operation in support of alternate reactor operating plans; (5) develop new fuel fabrication techniques to extend the capabilities for fuel fabrication within the N-Reactor Department; (6) initiate equipment design and procurement actions as necessary to provide capability to meet production schedules.

5092 (WAPD-T–3020) **Chemical reactions during ThO_2 and ThO_2-UO_2 fuel fabrication.** Clayton, J.C. Westinghouse Electric Corp., West Mifflin, PA (United States). Bettis Atomic Power Lab. [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-940817–2: World congress in particle technology, Denver, CO (United States), 17-20 Aug 1994). Order Number DE94017063. Source: OSTI; NTIS; INIS; GPO Dep.

The chemical reactions that occur during the fabrication of fuel pellets for the Shipping port Light Water Breeder Reactor are discussed. These include (1) precipitation and pyrolysis of thorium oxalate, (2) precipitation, calcination, and hydrogen reduction of ammonium diuranate, (3) comminution, granulation with an organic binder, and cold compaction of ThO_2 and ThO_2-UO_2 powders, (4) decarburization of the organic binder in CO_2 at temperature up to 925 C, and (5) sintering in moist hydrogen at temperature up to 1790 C. Thorium oxalate precipitation and pyrolysis temperatures were the primary process variables for controlling the resulting thoria powder properties. Coprecipitated metal sulfates were converted to transition metal sulfides during calcining - the conversion of thorium oxalate to thorium oxide. The critical variable for controlling the urania powder properties was the hydrogen reduction temperature. Thermodynamic analyses showed that the efficiency of carbon removal from cold-compacted ThO_2 and ThO_2-UO_2 pellets by CO_2 oxidation increases with temperature and, at temperatures around 900 C, substantially complete oxidation of carbon to carbon monoxide gas should occur. The carbon content of the ThO_2 and ThO_2-UO_2 fuels was further reduced during the initial heating in the hydrogen sintering cycle through the formation of methane gas. Additions of water vapor to the hydrogen sintering atmosphere also aided in carbon removal.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 5230, 5410, 5418, 5440, 5441, 5455, 5465, 5466, 5845, 5846, 5847, 6271

5093 (DPW–55-15-3) **Minutes of Technical Division Steering Committee meeting March, 8, 1955, Savannah River Laboratory.** Evans, L.C. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Explosives Dept. 15 Mar 1955. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–937). Order Number DE95004913. Source: OSTI; NTIS; GPO Dep.

Nine technical studies were approved for funding. Discussions at the meeting centered around safety and work schedules. Appendices contain information on Financial status, the Separations program, the Analytical Chemistry program, and the Technical Division studies that were approved at the meeting.

5094 (DPW–56-167) **Scope of work – Evaluation estimate of a U-235 recovery plant.** Jenkins, W.A. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Explosives Dept. 1 Mar 1956. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–938). Order Number DE95004914. Source: OSTI; NTIS; GPO Dep.

This letter defines the scope of the Evaluation Estimate to be made on a U-235 recovery plant proposed for construction at Savannah River. The purpose of the plant will be to purify and recover the uranium (principally U-235 and U-236) from highly irradiated enriched fuel tubes (currently designated Mark VI and VIa). The uranium will be purified such that it presents no radioactivity hazard to personnel when handled in critically safe, unshielded, tube type shipping containers. The product will be shipped off-site as a nitrate solution containing about 350 g U/liter and about 0.8 molar in nitric acid.

5095 (DPW–56-311) **Trip report, July 1956.** Thayer, V.R. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Atomic Energy Div. 1 Aug 1956. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–792). Order Number DE94018523. Source: OSTI; NTIS; GPO Dep.

This is an historic travel report on the current happenings at three locations: Hanford Plant, University of California (Radiation Laboratory) and Los Alamos Scientific Laboratory.

5096 (HDC–1131) **Redox Committee: Conference notes and recommendations, April 5, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 5 Apr 1949. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–939). Order Number DE95004915. Source: OSTI; NTIS; GPO Dep.

The notes and recommendations contained in this report relate to the design and construction of the Redox Production Plant with its associated Tank Farm at Hanford. All current development work for the Redox Program was to be transferred to the Redox Production Plant. [The Redox plant used a reduction-oxidation process for fuel separation that allowed recovery of uranium as well as plutonium for the first time. It succeeded earlier plants (T and B) that used methods based on the bismuth phosphate process that recovered only plutonium.]

5097 (HDC–1162) **Redox Committee: Conference notes and recommendations, meeting of April 11, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Hanford Works, Richland, WA (United States). 11 Apr 1949. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–940). Order Number DE95004916. Source: OSTI; NTIS; GPO Dep.

This report discusses recommendations for development work on the Redox Production Plant. It contains an outline for a relationship procedure between the architect engineer and General Electric Design Division; preparation of a material balance and process flow; the preparation of engineering flow diagrams, including lists of standard symbols for these diagrams; a material and equipment list; a project cost estimate; and Procedures covering institution and execution of work involving studies by the Design and Construction Division.

5098 (HDC–1216) **Redox Committee: Conference notes and recommendations, meeting of May 16, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 16 May 1949. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–941). Order Number DE95004917. Source: OSTI; NTIS; GPO Dep.

The recommendations include the adoption of aluminum nitrate recovery as part of the Redox Program and construction of a Waste Tank Farm. The report also lists recommendations which were submitted to this Committee for consideration. [The Redox plant used a reduction-oxidation process for fuel separation that allowed recovery of uranium as well as plutonium for the first time.]

5099 (HDC–1232) **Redox Committee: Conference notes, meeting of May 23, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 23 May 1949. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–942). Order Number DE95004918. Source: OSTI; NTIS; GPO Dep.

Discussions included the aluminum nitrate recovery process; specifications for process pumps; a review of the safety of the Redox process; plans for the proposed Waste Tank Farm, retention basin, diversion box, and cribs; and a request from the US AEC for a concise summary of the entire Redox program.

5100 (HDC–1253) **Redox Committee: Conference notes and recommendations, meeting of June 2, 1949.** Beaton, R.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 3 Jun 1949. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–943). Order Number DE95004919. Source: OSTI; NTIS; GPO Dep.

Recommendations included omitting the aluminum nitrate recovery process from the Redox Production Plant design; "hot" maintenance shop requirements for the Redox Production Plant; plans for waste disposal facilities; and agreement to study further the suggestion to place the extraction columns into a silo.

5101 (HDC–1278) **Redox Committee: Conference notes and recommendations, meeting of June 9, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 9 Jun 1949. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–944). Order Number DE95004920. Source: OSTI; NTIS; GPO Dep.

The report includes recommendations on flow sketches; 68% nitric acid specifications; dissolver off-gas and ventilation air treatment; installation of standby equipment (details included in Appendix A); schedule of scope drawing specifications and arrangement drawings; mechanical development program (details included in Appendix B); and scope of work on waste disposal facilities (Appendix C).

5102 (HDC–1284) **Redox Committee: Conference notes and recommendations, meeting of June 13, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 14 Jun 1949. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–945). Order Number DE95004921. Source: OSTI; NTIS; GPO Dep.

Recommendations discussed included the transfer of Waste Metal Recovery from the Kellex Corporation; the Kellex contract revisions for their work on the design of the Redox Production Plant; procurement and inspection procedures; aluminum nitrate supply and procurement; and waste recovery with the tributyl phosphate and hexane process.

5103 (HDC–1291) **Redox Committee: Conference notes and recommendations, meeting of June 16, 1949.** Greager, O.H.; MacCready, W.K.; Seckendorff, E.W. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 20 Jun 1949. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–946). Order Number DE95004922. Source: OSTI; NTIS; GPO Dep.

Topics discussed included scope of work by the Kellex Corporation; Redox Production Plant procurement; bearing capacity of soils and other site characterization for the Redox Production Plant site; purchase of Moyno pumps; scope drawing schedules; 68% nitric acid requirements for the process; pump development for the Redox Production Plant; vessel specifications; Design basis letters on electrical distribution, steam distribution, raw and filtered water distribution, and railroads. The report includes a letter on materials of construction for 202-S building equipment.

5104 (HDC–1304) **Redox Committee: Conference notes and recommendations, meeting of June 23, 1949.** Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). 23 Jun 1949. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–947). Order Number DE95004923. Source: OSTI; NTIS; GPO Dep.

Topics discussed include gang valve substitute devices; cost of lining cell bottom with stainless steel; and the pump development program. [The Redox plant used a reduction-oxidation process for fuel separation that allowed recovery of uranium as well as plutonium for the first time. It succeeded earlier plants (T and B) that had used methods based on the bismuth phosphate process that recovered only plutonium.]

5105 (JAERI-Tech–94-008) **Development of partitioning method: engineering-scale test on partitioning process. 1. Demonstration of TRU separation by solvent extraction process experimental apparatus.** Kondo, Yasuo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Fujiwara, Takeshi; Morita, Yasuji; Kubota, Masumitsu. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 44p. (In Japanese). Order Number DE95737219. Source: OSTI; NTIS; INIS.

A solvent extraction process experimental apparatus was designed as an engineering scale test facility for the TRU extraction process of four-group partitioning process. This apparatus has a feature that a variable bank-stage mixer-settler fixed together 2 or 4 stages banks makes it possible to examine the solvent extraction characteristics with various sets of organic and aqueous solutions. A demonstration test used a simulated solution with La and Nd showed that the variable bank-stage mixer-settler had an expected extractability of TRU from the solution, irrespective of the number

of bank-stage. In addition, the leakage and discontinuity of flow patterns of organic and aqueous solutions were not found at the joint of the banks in the mixer-settler. We may conclude that this apparatus would be useful enough to examine the extraction characteristics of TRU by various organic solvents on an engineering scale. (author).

5106 (WHC-SD-CP-MAR–001) **Plutonium Finishing Plant Transition Project mission analysis report.** Courson, D.B. Westinghouse Hanford Co., Richland, WA (United States). 21 Sep 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95000991. Source: OSTI; NTIS; INIS; GPO Dep.

This report defines the mission for the Plutonium Finishing Plant Transition Project (PFPTP) using a systems engineering approach. This mission analysis will be the basis for the functional analysis which will further define and break down the mission statement into all of the detailed functions required to accomplish the mission. The functional analysis is then used to develop requirements, allocate those requirements to functions, and eventually be used to design the system. This report: presents the problem which will be addressed, defines PFP Transition Project, defines the overall mission statement, describes the existing, initial conditions, defines the desired, final conditions, identifies the mission boundaries and external interfaces, identifies the resources required to carry out the mission, describes the uncertainties and risks, and discusses the measures which will be used to determine success.

5107 (WHC-SD-CP-TEEM–069) **PFP up-right lift UL-20/26 manlifts.** Morley, J.M. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003839. Source: OSTI; NTIS; INIS; GPO Dep.

This Technical Evaluation of Equipment Maintenance (TEEM) is provided principally to document vendor suggested maintenance requirements and deviations from vendor suggested requirements, and provide documentation to support PM procedures. As additional maintenance activities are identified, they will be documented in later revisions. This TEEM is applicable to four single-person manlifts. The report documents preventive maintenance evaluations, semi-annual checks, safety rules before the use of the manlifts, and routine service checks.

5108 (WSRC-IM–94-39) **History of 232-F, tritium extraction processing.** Blackburn, G.W. Westinghouse Savannah River Co., Aiken, SC (United States). Aug 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95004407. Source: OSTI; NTIS; INIS; GPO Dep.

In 1950 the Atomic Energy Commission authorized the Savannah River Project principally for the production of tritium and plutonium-239 for use in thermonuclear weapons. 232-F was built as an interim facility in 1953–1954, at a cost of $3.9M. Tritium extraction operations began in October, 1955, after the reactor and separations startups. In July, 1957 a larger tritium facility began operation in 232-H. In 1958 the capacity of 232-H was doubled. Also, in 1957 a new task was assigned to Savannah River, the loading of tritium into reservoirs that would be actual components of thermonuclear weapons. This report describes the history of 232-F, the process for tritium extraction, and the lessons learned over the years that were eventually incorporated into the new Replacement Tritium Facility.

5109 (WSRC-TR–94-0372) **Safe handling of TBP and nitrates in the nuclear process industry.** Hyder, M.L. Westinghouse Savannah River Co., Aiken, SC (United States). Jul 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003895. Source: OSTI; NTIS; INIS; GPO Dep.

A laboratory and literature study was made of the reactions of tri-n-butyl phosphate (TBP) with nitric acid and nitrates. Its goal was to establish safe conditions for solvent extraction processes involving these chemicals. The damaging explosions at the Tomsk-7 PUREX plant in Russia graphically illustrated the potential hazard involved in such operations. The study has involved a review of prior and contemporary experiments, and new experiments to answer particular questions about these reactions. TBP extracts nitric acid and some metal nitrates from aqueous solutions. The resulting liquid contains both oxidant and reductant, and can react exothermically if heated sufficiently. Safe handling of these potentially reactive materials involves not only limiting the heat generated by the chemical reaction, but also providing adequate heat removal and venting. Specifically, the following recommendations are made to ensure safety: (1) tanks in which TBP-nitrate complexes are or may be present should be adequately vented to avoid pressurization. Data are supplied as a basis for adequacy; (2) chemically degraded TBP, or TBP that has sat a long time in the presence of acids or radiation, should be purified before use in solvent extraction; (3) evaporators in which TBP might be introduced should be operated at a controlled temperature, and their TBP content should be limited; (4) evaporator bottoms that may contain TBP should be cooled under conditions that ensure heat removal. Finally, process design should consider the potential for such reactions, and operators should be made aware of this potential, so that it is considered during training and process operation.

5110 (WSRC-TR–94-0437-Rev.1) **Mass transfer model for two-layer TBP oxidation reactions: Revision 1.** Laurinat, J.E. Westinghouse Savannah River Co., Aiken, SC (United States). 4 Nov 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95004348. Source: OSTI; NTIS; INIS; GPO Dep.

To prove that two-layer, TBP-nitric acid mixtures can be safely stored in the Canyon evaporators, it must be demonstrated that a runaway reaction between TBP and nitric acid will not occur. Previous bench-scale experiments showed that, at typical evaporator temperatures, this reaction is endothermic and therefore cannot run away, due to the loss of heat from evaporation of water in the organic layer. However, the reaction would be exothermic and could run away if the small amount of water in the organic layer evaporates before the nitric acid in this layer is consumed by the reaction. Provided that there is enough water in the aqueous layer, this would occur if the organic layer is sufficiently thick so that the rate of loss of water by evaporation exceeds the rate of replenishment due to mixing with the aqueous layer. Bubbles containing reaction products enhance the rate of transfer of water from the aqueous layer to the organic layer. These bubbles are generated by the oxidation of TBP and its reaction products in the organic layer and by the oxidation of butanol in the aqueous layer. Butanol is formed by the hydrolysis of TBP in the organic layer. For aqueous-layer bubbling to occur, butanol must transfer into the aqueous layer. Consequently, the rate of oxidation and bubble generation in the aqueous layer strongly depends on the rate of transfer of butanol from the organic to the aqueous layer. This report presents measurements of mass transfer rates for the mixing of water and butanol in two-layer, TBP-aqueous mixtures, where the top layer is primarily TBP and the bottom layer is comprised of water or aqueous salt solution. Mass transfer coefficients are derived for use in the modeling of two-layer TBP-nitric acid oxidation experiments.

0509 Transport, Handling, and Storage

Refer also to citation(s) 5446, 5848, 6298, 6324, 6325, 6330

5111 (DOE–0227-2-Rev.1) **Quality Assurance Plan for Transportation Management Division Transportation Training Programs.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Transportation Management Div. Oct 1994. 72p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003991. Source: OSTI; NTIS; INIS; GPO Dep.

The U.S. Department of Transportation (DOT) implemented new rules requiring minimum levels of training for certain key individuals who handle, package, transport, or otherwise prepare hazardous materials for transportation. In response to these rules, the U.S. Department of Energy (DOE), Transportation Management Division (TMD), has developed a transportation safety training program. This program supplies designed instructional methodology and course materials to provide basic levels of DOT training to personnel for whom training has become mandatory. In addition, this program provides advanced hazardous waste and radioactive material packaging and transportation training to help personnel

achieve proficiency and/or certification as hazardous waste and radioactive material shippers. This training program does not include site-specific or task-specific training beyond DOT requirements.

5112 (DOE-STD–3013-94) **Criteria for safe storage of plutonium metals and oxides.** USDOE, Washington, DC (United States). Dec 1994. 35p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004199. Source: OSTI; NTIS; GPO Dep.

This standard establishes safety criteria for safe storage of plutonium metals and plutonium oxides at DOE facilities; materials packaged to meet these criteria should not need subsequent repackaging to ensure safe storage for at least 50 years or until final disposition. The standard applied to Pu metals, selected alloys (eg., Ga and Al alloys), and stabilized oxides containing at least 50 wt % Pu; it does not apply to Pu-bearing liquids, process residues, waste, sealed weapon components, or material containing more than 3 wt % ^{238}Pu. Requirements for a Pu storage facility and safeguards and security considerations are not stressed as they are addressed in detail by other DOE orders.

5113 (EGG-WM–10774-Rev.2) **Safety analysis report for the Waste Storage Facility. Revision 2.** Bengston, S.J. EG and G Idaho, Inc., Idaho Falls, ID (United States). May 1994. 328p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE95002039. Source: OSTI; NTIS; GPO Dep.

This safety analysis report outlines the safety concerns associated with the Waste Storage Facility located in the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory. The three main objectives of the report are: define and document a safety basis for the Waste Storage Facility activities; demonstrate how the activities will be carried out to adequately protect the workers, public, and environment; and provide a basis for review and acceptance of the identified risk that the managers, operators, and owners will assume.

5114 (EGG-WM–10877-Rev.1) **Waste Management Facilities Cost Information for transportation of radioactive and hazardous materials. Revision 1.** Feizollahi, F. (Morrison Knudsen Corp., San Francisco, CA (United States)); Shropshire, D.; Burton, D. EG and G Idaho, Inc., Idaho Falls, ID (United States). Sep 1994. 203p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE95002022. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains transportation costs for most types of DOE waste streams: low-level waste (LLW), mixed low-level waste (MLLW), alpha LLW and alpha MLLW, greater-than-Class C (GTCC) LLW and DOE equivalent waste, transuranic waste (TRU), spent nuclear fuel (SNF), and hazardous waste. Unit rates for transportation of contact-handled (<200 mrem/hr contact dose) and remote-handled (>200 mrem/hr contact dose) radioactive waste have been estimated previously, and a summary has been included in earlier WMFCI reports. In order to have a single source for obtaining transportation cost for all radioactive waste, the transportation costs for the contact- and remote-handled wastes are repeated in this report. Land transportation of radioactive and hazardous waste is subject to regulations promulgated by DOE, the US Department of Transportation (DOT), the US Nuclear Regulatory Commission (NRC), and state and local agencies. The cost estimates in this report assume compliance with applicable regulations. It should be noted that the trend is toward greater restrictions on transportation of radioactive waste (e.g., truck or rail car speed, shipping route, security escort, and personnel training requirements), which may have a significant impact on future costs.

5115 (K/TCD–1120) **Corrosion monitoring in the UF_6 cylinder yards at the Oak Ridge K-25 Site: FY 1994 report.** Rao, M. (Midwest Technical Inc., Oak Ridge, TN (United States)); Adamski, R.; Broders, J.; Ellis, A.; Freels, D.; Kelley, D.; Phillips, B. Oak Ridge K-25 Site, TN (United States); Midwest Technical, Inc., Oak Ridge, TN (United States). Oct 1994. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE95004392. Source: OSTI; NTIS; GPO Dep.

Depleted uranium hexafluoride (UF_6) at the U.S. Department of Energy's K-25 Site at Oak Ridge, Tennessee, has been stored in large steel cylinders that have undergone significant atmospheric corrosion damage over the last 35 years. A detailed experimental program to characterize the corrosion damage was initiated in 1992. Large amounts of corrosion scale and deep pits are found to cover UF_6 cylinder surfaces. Ultrasonic wall thickness measurements have shown uniform corrosion losses up to 20 mils (0.5 mm) and pits up to 100 mils (2.5 mm) deep. Electrical resistance corrosion probes, TOW sensors, and thermocouples have been attached to cylinder bodies. Atmospheric conditions are monitored using rain gauges, relative humidity sensors, and thermocouples. Long-term (16-year) data are being obtained from mild steel corrosion coupons on test racks as well as attached directly to cylinder surfaces. Corrosion rates have been found to be intimately related to the times-of-wetness, both tending to be higher on cylinder tops due to apparent sheltering effects. Data from the various tests are compared, discrepancies are discussed, and a pattern of cylinder corrosion as a function of cylinder position and location is described.

5116 (WHC-SA–2508) **Interim dry cask storage of irradiated Fast Flux Test Facility fuel.** Scott, P.L. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-941207–17: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95004144. Source: OSTI; NTIS; INIS; GPO Dep.

The Fast Flux Test Facility (FFTF), located at the US Department of Energy's (DOE'S) Hanford Site, is the largest, most modern, liquid metal-cooled test reactor in the world. This paper will give an overview of the FFTF Spent Fuel Off load project. Major discussion areas will address the status of the fuel off load project, including an overview of the fuel off load system and detailed discussion on the individual components that make up the dry cask storage portion of this system. These components consist of the Interim Storage Cask (ISC) and Core Component Container (CCC). This paper will also discuss the challenges that have been addressed in the evolution of this project.

5117 (WHC-SD-CP-DA–093) **Slug bucket lifting yoke analysis.** McElfresh, A.J. Westinghouse Hanford Co., Richland, WA (United States). 14 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003765. Source: OSTI; NTIS; INIS; GPO Dep.

There are baskets of fuel in the storage pools in the Purex facility (202-A). These baskets (called slug buckets) need to be removed from Purex and taken to the K-Basins. The current slug bucket lifting yoke is of sufficient age to be in question structurally. Therefore new yokes need to be fabricated. Prior to fabricating new yokes, the slug bucket lifting yoke DWG needs to be updated for fabrication. However, the design needs to be refined so that the yoke will be easier to fabricate. These calculations are prepared to demonstrate the adequacy of the new design. The objective of these calculations is to select appropriately sized structural members and weld sizes to serve as components in the slug bucket lifting yoke.

5118 (WHC-SD-NR-ANAL–014) **Consolidated fuel decay heat calculations.** Wittekind, W.D. Westinghouse Hanford Co., Richland, WA (United States). 24 Jun 1994. 82p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94017999. Source: OSTI; NTIS; INIS; GPO Dep.

The radiological decay heat generated from all irradiated fuel presently in K East (KE) and K West (KW) Basins was calculated in support of consolidated fuel storage. There are four sources of heat inflow into the fuel storage basins: (1) radiological decay heat from irradiated fuel; (2) mechanical heat from operating machinery (e.g., pumps); (3) heat flow from surroundings (mainly the ground through the concrete walls into the basin water if it is maintained below ambient); and (4) exothermic chemical reactions of uranium oxidation (although at basin temperatures this reaction rate is slow). This report details the radiological decay heat from irradiated fuel source in the K basins. Decay heat calculations using ORIGEN2 (Wittekind 1994 and Schmittroth 1993) for irradiated fuel presently (April 1994) in KE and KW Basins gave results for January 31 of each year.

5119 (WHC-SD-SNF-ER–002) **K-Basin isolation barrier seal.** Ruff, E.S. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 97p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003861. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents various aspects of the design, analysis, procurement, and fabrication of the hydraulic seal on the isolation barriers to be installed in the 100-K Area spent nuclear fuel basin. The isolation barrier is used to keep water in the basin in the event of an earthquake.

5120 (WHC-SD-SNF-ES–002) **Engineering study: 105KE to 105KW Basin fuel and sludge transfer. Final report.** Gant, R.G. (Westinghouse Hanford Co., Richland, WA (United States)). Westinghouse Hanford Co., Richland, WA (United States); Columbia Energy and Environmental Services, Inc., Richland, WA (United States). 20 Sep 1994. 73p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001033. Source: OSTI; NTIS; INIS; GPO Dep.

In the last five years, there have been three periods at the 105KE fuel storage basin (KE Basin) where the reported drawdown test rates were in excess of 25 gph. Drawdown rates in excess of this amount have been used during past operations as the primary indicators of leaks in the basin. The latest leak occurred in March, 1993. The reported water loss from the KE Basin was estimated at 25 gph. This engineering study was performed to identify and recommend the most feasible and practical method of transferring canisters of irradiated fuel and basin sludge from the KE Basin to the 105KW fuel storage basin (KW Basin). Six alternatives were identified during the performance of this study as possible methods for transferring the fuel and sludge from the KE Basin to the KW Basin. These methods were then assessed with regard to operations, safety, radiation exposure, packaging, environmental concerns, waste management, cost, and schedule; and the most feasible and practical methods of transfer were identified. The methods examined in detail in this study were based on shipment without cooling water except where noted: Transfer by rail using the previously used transfer system and water cooling; Transfer by rail using the previously used transfer system (without water cooling); Transfer by truck using the K Area fuel transfer cask (K Area cask); Transfer by truck using a DOE shipping cask; Transfer by truck using a commercial shipping cask; and Transfer by truck using a new fuel shipping cask.

5121 (WHC-SD-SNF-PMP–002) **Project Management Plan 105-KE Basin sludge retrieval and packaging.** McWethy, L.M. Westinghouse Hanford Co., Richland, WA (United States). 7 Nov 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003777. Source: OSTI; NTIS; INIS; GPO Dep.

The KE Basin contains over 1,100 metric tons of spent nuclear fuel (SNF). The bulk of this inventory consists of over 50,000 zircaloy clad, uranium metal N-Reactor fuel element assemblies, along with less than half a metric ton of single-pass reactor fuel elements, stored in over 3,600 open top canister assemblies. In addition, sludge containing fissile and fission product material from damaged/degraded fuel has accumulated in the basin. The sludge, particularly the fines, impacts basin operations by clouding the water and making activities requiring a clear view impossible to complete until after sludge settles. Packaging would get the sludge out of the operator's way and allow it to be moved within the basin in a more manageable state. The primary project objective is to develop, procure, and quality the equipment needed to remove all sludge from the KE Basin with minimal dose commitment, minimal cost, and on schedule. The project will provide: (1) the development, testing, and installation of equipment for sludge retrieval and packaging; (2) understanding of and experience with actual sludge through near-term sludge packaging feature tests in the KE Basin; (3) sludge removal and handling equipment required to support debris removal, fuel handling, and other activities involving sludge within the KE Basin; and (4) enlist industry expertise in all phases of the project. This Project Management Plant establishes the organizational responsibilities, control systems, and procedures for the execution of project activities for KE Basin sludge retrieval packaging, to meet programmatic requirements within authorized funding and approved schedules.

5122 (WHC-SD-SNF-TI–001) **Hanford spent fuel inventory baseline.** Bergsman, K.H. Westinghouse Hanford Co., Richland, WA (United States). 15 Jul 1994. 141p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94016468. Source: OSTI; NTIS; INIS; GPO Dep.

This document compiles technical data on irradiated fuel stored at the Hanford Site in support of the Hanford SNF Management Environmental Impact Statement. Fuel included is from the Defense Production Reactors (N Reactor and the single-pass reactors; B, C, D, DR, F, H, KE and KW), the Hanford Fast Flux Test Facility Reactor, the Shipping port Pressurized Water Reactor, and small amounts of miscellaneous fuel from several commercial, research, and experimental reactors.

5123 (WHC-SD-SNF-WP–010) **Work plan for integrated sludge packaging demonstration.** Brisbin, S.A. Westinghouse Hanford Co., Richland, WA (United States). 7 Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003776. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes the tasks which will be performed to support the hot demonstration of the integrated sludge packaging system to package the sludge that has accumulated in the KE Basin. This activity will be performed in three phases: Phase 1 will consist of testing component and sub-system performance using a surrogate sludge, Phase 2 will consist of cold testing the integrated sludge packaging system using a surrogate sludge, and Phase 3 will consist of the hot demonstration of the integrated sludge packaging system.

5124 (WHC-SD-SNF-WP–011) **Work plan for development of K-Basin fuel handling tools.** Bridges, A.E. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003855. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to provide the engineering work plan for the development of handling tools for the removal of N-Reactor fuel elements from their storage canisters in the K-Basins storage pool and insertion into the Single Fuel Element Cans for subsequent shipment to a Hot Cell for examination. Examination of these N-Reactor fuel elements is part of the overall characterization effort. New hand tools are required since previous fuel movement has involved grasping the fuel in a horizontal position. These tools are required to lift an element from the storage canister.

5125 (WHC-SD-TP-RPT–015) **Transportation impact analysis for the shipment of Low Specific Activity Nitric Acid.** Green, J.R. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003866. Source: OSTI; NTIS; INIS; GPO Dep.

This document was written in support of the Plutonium-Uranium Extraction (PUREX) Facility Low Specific Activity (LSA) Nitric Acid Shipment Environmental Assessment. It analyzes the potential toxicological and radiological risks associated with the transportation of PUREX Facility LSA Nitric Acid from the Hanford Site in Washington State to three Eastern ports.

5126 (WHC-SD-W221-DP–001) **[Phase 2, Solid Waste Retrieval Trench characterizations].** Johnson, D.M. Westinghouse Hanford Co., Richland, WA (United States). [1994]. 88p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95002360. Source: OSTI; NTIS; GPO Dep.

The abstract was presented in the form of illustrations regarding radioactive waste disposal trenches.

5127 (WHC-SD-WM-AP–030-Rev.1) **Location of equipment in the 105K East discharge chute for installation of isolation barriers (ref USQ 94-0041): Revision 1.** Hull, T.R. Westinghouse Hanford Co., Richland, WA (United States). 4 Nov 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract

AC06-87RL10930. Order Number DE95003840. Source: OSTI; NTIS; INIS; GPO Dep.

The scope of this report is to document the final location for equipment currently located in the 105 K-East discharge chute before beginning installation of the isolation barriers and equipment that will/may be left after completion of installation. The isolation barriers are to be installed at each basin in the openings between the discharge chute and the main basin. Once installed, the isolation barriers will remain in place, permanently isolating the discharge chute from direct communication with the main basin. After the isolation barriers are installed, the equipment left in the discharge chute will not be able to be moved out of the chute without being totally removed from the water. The equipment that will be addressed by this Supporting Document includes: Crusher, Dump Table, Packager, Seal Conveyor, Old Cofferdam Doors, Joint Cover and Location Bars, Canister Basket, Air Operated Sludge Pump and Discharge Hose, Fuel Segregation Canister Table, Seal Preparation Tool, and Miscellaneous tools and equipment.

5128 (WHC-SP–1104) **Spent nuclear fuels project: FY 1995 multi-year program plan, WBS #1.4.** Denning, J.L. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 312p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001402. Source: OSTI; NTIS; INIS; GPO Dep.

The mission of the Spent Nuclear Fuel (SNF) program is to safely, reliably, and efficiently manage, condition, transport, and store Department of Energy (DOE)-owned SNF, so that it meets acceptance criteria for disposal in a permanent repository. The Hanford Site Spent Nuclear Fuel strategic plan for accomplishing the project mission is: Establish near-term safe storage in the 105-K Basins; Complete national Environmental Policy Act (NEPA) process to obtain a decision on how and where spent nuclear fuel will be managed on the site; Define and establish alternative interim storage on site or transport off site to support implementation of the NEPA decision; and Define and establish a waste package qualified for final disposition. This report contains descriptions of the following: Work Breakdown Structure; WBS Dictionary; Responsibility Assignment Matrix; Program Logic Diagrams; Program Master Baseline Schedule; Program Performance Baseline Schedule; Milestone List; Milestone Description Sheets; Cost Baseline Summary by Year; Basis of Estimate; Waste Type Data; Planned Staffing; and Fiscal Year Work Plan.

5129 (WSRC-MS–94-0493) **Technology risk assessment of foreign research reactor spent nuclear fuel dry storage.** Vashi, K.M.; Calta, R.F. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–3: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95000750. Source: OSTI; NTIS; INIS; GPO Dep.

Westinghouse Savannah River Company (WSRC) conducted a technology risk assessment (TRA) which identified 36 risks associated with dry storage of Foreign Research Reactor (FRR) Spent Nuclear Fuel (SNF). This assessment was based on storage of the FRR SNF at the Savannah River Site (SRS), Aiken, South Carolina. These risks, which were identified in five functional areas, will be addressed in a multitude of mitigation efforts to ensure program mission objectives are not jeopardized. Many of the identified risks were determined to be applicable to any planned United States (US) Department of Energy (DOE) spent nuclear fuel dry storage mission.

0510 Economic, Industrial, and Business Aspects

Refer also to citation(s) 5987

0520 Waste Management

Refer also to citation(s) 5096, 5098, 5099, 5100, 5101, 5113, 5125, 5126, 5129, 5368, 5388, 5391, 5406, 5412, 5415, 5428, 5436, 5443, 5445, 5450, 5451, 5454, 5456, 5457, 5458, 5459, 5460, 5461, 5463, 5464, 5466, 5477, 5479, 5750, 5845, 6264, 6275, 6287, 6288, 6297, 6306, 6326, 6327, 6328, 6333, 6562, 6563, 6565, 6566, 7017, 7018, 7054, 7080, 7081

5130 (ANL/CMT/CP–82509) **Comparison of glassy slag waste forms produced in laboratory crucibles and in a bench-scale plasma furnace.** Feng, X. (Argonne National Lab., IL (United States)); Wronkiewicz, D.J.; Brown, N.R.; Gong, M.; Whitworth, C.; Filius, K.; Battleson, D. Argonne National Lab., IL (United States); MSE, Inc., Butte, MT (United States). [1994]. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38 ; AC22-88ID12735. (CONF-9409178–8: American Chemical Society meeting on industrial and engineering chemistry, Atlanta, GA (United States), 19-21 Sep 1994). Order Number DE95001441. Source: OSTI; NTIS; INIS; GPO Dep.

Vitrification is currently the best demonstrated available technology for the disposal of high-level radioactive wastes. An innovative vitrification approach known as minimum additive waste stabilization (MAWS) is being developed. Both homogeneous glass and glassy slags have been used in implementing MAWS. Glassy slags (vitro-ceramics) are glass-crystal composites, and they are composed of various metal oxide crystalline phases embedded in an aluminosilicate glass matrix. Glassy slags with compositions developed in crucible melts at Argonne National Laboratory (ANL) were successfully produced in a bench-scale Retech plasma centrifugal furnace (PCF) by MSE, Inc. Detailed examinations of these materials showed that the crucible melts and the PCF produced similar glass and crystalline phases. The two sets of glassy slags exhibited similar chemical durability in terms of normalized releases of their major components. The slags produced in the PCF furnace using metals were usually less oxidized, although this had no effect on the corrosion behavior of the major components of the slags. However, the normalized release rate of cerium was initially lower for the PCF slags. This difference diminished with time as the redox sates of the metal oxides in slags began to be controlled by exposure to air in the tests. Thus, the deference in cerium release due to the differences in slag redox state may be transitory. The cerium solubility is a complex function of redox state and solution pH and Eh.

5131 (ANL/DIS/TM–17) **Stigma models: Testing hypotheses of how images of Nevada are acquired and values are attached to them.** Jenkins-Smith, H.C. (New Mexico Univ., Albuquerque, NM (United States)). Argonne National Lab., IL (United States). Decision and Information Sciences Div.; New Mexico Univ., Albuquerque, NM (United States). Dec 1994. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95004985. Source: OSTI; NTIS; INIS; GPO Dep.

This report analyzes data from surveys on the effects that images associated with nuclear power and waste (i.e., nuclear images) have on people's preference to vacation in Nevada. The analysis was stimulated by a model of imagery and stigma which assumes that information about a potentially hazardous facility generates signals that elicit negative images about the place in which it is located. Individuals give these images negative values (valences) that lessen their desire to vacation, relocate, or retire in that place. The model has been used to argue that the proposed Yucca Mountain high-level nuclear waste repository could elicit images of nuclear waste that would stigmatize Nevada and thus impose substantial economic losses there. This report proposes a revised model that assumes that the acquisition and valuation of images depend on individuals' ideological and cultural predispositions and that the ways in which new images will affect their preferences and behavior partly depend on these predispositions. The report tests these hypotheses: (1) individuals with distinct cultural and ideological predispositions have different propensities for acquiring nuclear images, (2) these people attach different valences to these images, (3) the variations in these valences are important, and (4) the valences of the different categories of images within an individual's image sets for a place correlate very well. The analysis largely confirms these hypotheses, indicating that the stigma model should be revised to (1) consider the relevant ideological and cultural predispositions of the people who will potentially acquire and attach value to the image, (2) specify the kinds of images that previously attracted people to the host state,

and (3) consider interactions between the old and potential new images of the place. 37 refs., 18 figs., 17 tabs.

5132 (BHI–00007) **Prototype Hanford Surface Barrier: Design basis document.** Myers, D.R.; Duranceau, D.A. Bechtel Hanford, Inc., Richland, WA (United States). Nov 1994. 246p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12367. Order Number DE95005256. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Site Surface Barrier Development Program (BDP) was organized in 1985 to develop the technology needed to provide a long-term surface barrier capability for the Hanford Site and other arid sites. This document provides the basis of the prototype barrier. Engineers and scientists have momentarily frozen evolving barrier designs and incorporated the latest findings from BDP tasks. The design and construction of the prototype barrier has required that all of the various components of the barrier be brought together into an integrated system. This integration is particularly important because some of the components of the protective barreir have been developed independently of other barreir components. This document serves as the baseline by which future modifications or other barrier designs can be compared. Also, this document contains the minutes of meeting convened during the definitive design process in which critical decisions affecting the prototype barrier's design were made and the construction drawings.

5133 (CONF-941244–1) **Position paper on gas generation in the Waste Isolation Pilot Plant.** Brush, L.H. USDOE Carlsbad Area Office, NM (United States). 15 Nov 1994. 111p. Sponsored by USDOE, Washington, DC (United States). From System prioritization method workshop; Carlsbad, NM (United States); 8-9 Dec 1994. Order Number DE95003738. Source: OSTI; NTIS; INIS; GPO Dep.

Gas generation by transuranic (TRU) waste is a significant issue because gas will, if produced in significant quantities, affect the performance of the Waste Isolation Pilot Plant (WIPP) with respect to Environmental Protection Agency (EPA) regulations for the long-term isolation of radioactive and chemically hazardous waste. If significant gas production occurs, it will also affect, and will be affected by, other processes and parameters in WIPP disposal rooms. The processes that will produce gas in WIPP disposal rooms are corrosion, microbial activity and radiolysis. This position paper describes these processes and the models, assumptions and data used to predict gas generation in WIPP disposal rooms.

5134 (CONF-941244–2-Rev.1) **Actinide Source Term Program, position paper. Revision 1.** Novak, C.F.; Papenguth, H.W.; Crafts, C.C.; Dhooge, N.J. USDOE Carlsbad Area Office, NM (United States). 15 Nov 1994. 35p. Sponsored by USDOE, Washington, DC (United States). From System prioritization method workshop; Carlsbad, NM (United States); 8-9 Dec 1994. Order Number DE95003737. Source: OSTI; NTIS; INIS; GPO Dep.

The Actinide Source Term represents the quantity of actinides that could be mobilized within WIPP brines and could migrate with the brines away from the disposal room vicinity. This document presents the various proposed methods for estimating this source term, with a particular focus on defining these methods and evaluating the defensibility of the models for mobile actinide concentrations. The conclusions reached in this document are: the 92 PA "expert panel" model for mobile actinide concentrations is not defensible; and, although it is extremely conservative, the "inventory limits" model is the only existing defensible model for the actinide source term. The model effort in progress, "chemical modeling of mobile actinide concentrations", supported by a laboratory effort that is also in progress, is designed to provide a reasonable description of the system and be scientifically realistic and supplant the "Inventory limits" model.

5135 (CONF-941244–Summ.) **Hazardous constituent source term. Revision 2.** USDOE, Washington, DC (United States). 17 Nov 1994. 24p. Sponsored by USDOE, Washington, DC (United States). From System prioritization method workshop; Carlsbad, NM (United States); 8-9 Dec 1994. Order Number DE95003736. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy (DOE) has several facilities that either generate and/or store transuranic (TRU)-waste from weapons program research and production. Much of this waste also contains hazardous waste constituents as regulated under Subtitle C of the Resource Conservation and Recovery Act (RCRA). Toxicity characteristic metals in the waste principally include lead, occurring in leaded rubber gloves and shielding. Other RCRA metals may occur as contaminants in pyrochemical salt, soil, debris, and sludge and solidified liquids, as well as in equipment resulting from decontamination and decommissioning activities. Volatile organic compounds (VOCS) contaminate many waste forms as a residue adsorbed on surfaces or occur in sludge and solidified liquids. Due to the presence of these hazardous constituents, applicable disposal regulations include land disposal restrictions established by Hazardous and Solid Waste Amendments (HSWA). The DOE plans to dispose of TRU-mixed waste from the weapons program in the Waste Isolation Pilot Plant (WIPP) by demonstrating no-migration of hazardous constituents. This paper documents the current technical basis for methodologies proposed to develop a post-closure RCRA hazardous constituent source term. For the purposes of demonstrating no-migration, the hazardous constituent source term is defined as the quantities of hazardous constituents that are available for transport after repository closure. Development of the source term is only one of several activities that will be involved in the no-migration demonstration. The demonstration will also include uncertainty and sensitivity analyses of contaminant transport.

5136 (DOE/AL/62350–56-Rev.5) **UMTRA technical assistance contractor quality assurance program plan.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Oct 1994. 79p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003910. Source: OSTI; NTIS; INIS; GPO Dep.

This Quality Assurance Program Plan (QAPP) provides the primary requirements for the integration of quality functions into all Technical Assistance Contractor (TAC) Project organization activities. The QAPP is the written directive authorized by the TAc Program Manager to accomplish this task and to implement procedures that provide the controls and sound management practices needed to ensure TAC contractual obligations are met. The QA program is designed to use monitoring, audit, and surveillance functions as management tools to ensure that all Project organization functions are executed in a manner that will protect public health and safety, promote the success of the Project, and meet or exceed contract requirements.

5137 (DOE/AL/62350–76-Rev.6) **UMTRA Project Office quality assurance program plan. Revision 6.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 81p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003915. Source: OSTI; NTIS; INIS; GPO Dep.

The Uranium Mill Tailings Remedial Action (UMTRA) Project was established to accomplish remedial actions at inactive uranium mill tailings sites. The UMTRA Project's mission is to stabilize and control the residual radioactive materials at designated sites in a safe and environmentally sound manner so as to minimize or eliminate radiation health hazards to the public. Because these efforts may involve possible risks to public health and safety, a quality assurance (QA) program that conforms to the applicable criteria has been established to control the quality of the work. This document, the Quality Assurance Program Plan (QAPP), brings into one document the essential criteria to be applied on a selective basis, depending upon the nature of the activity being conducted, and describes how those criteria shall be applied to the UMTRA Project. QA requirements contained in this QAPP shall apply to all personnel, processes, and activities, including planning, scheduling, and cost control, performed by the UMTRA Project Office and its contractors.

5138 (DOE/AL/62350–101) **Uranium Mill Tailings Remedial Action Project 1993 Environmental Report.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Oct 1994. 441p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003918. Source: OSTI; NTIS; INIS; GPO Dep.

This annual report documents the Uranium Mill Tailing Remedial Action (UMTRA) Project environmental monitoring and protection

program. The UMTRA Project routinely monitors radiation, radioactive residual materials, and hazardous constituents at associated former uranium tailings processing sites and disposal sites. At the end of 1993, surface remedial action was complete at 10 of the 24 designated UMTRA Project processing sites. In 1993 the UMTRA Project office revised the UMTRA Project Environmental Protection Implementation Plan, as required by the US DOE. Because the UMTRA Project sites are in different stages of remedial action, the breadth of the UMTRA environmental protection program differs from site to site. In general, sites actively undergoing surface remedial action have the most comprehensive environmental programs for sampling media. At sites where surface remedial action is complete and at sites where remedial action has not yet begun, the environmental program consists primarily of surface water and ground water monitoring to support site characterization, baseline risk assessments, or disposal site performance assessments.

5139 (DOE/AL/62350–153) **UMTRA Project Site Observational Work Plan, Mexican Hat, Utah.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 360p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003916. Source: OSTI; NTIS; INIS; GPO Dep.

Surface cleanup activities at the Mexican Hat UMTRA processing site are nearing completion. Ground Water contamination at the Mexican Hat site is a result of uranium milling operations. The extent of residual process water has been identified, and it is limited to the uppermost aquifer in the vicinity of the site. Deeper aquifers are not affected because of an upward hydraulic gradient and the presence of a confining unit (the deeper aquifers are protected by hydrogeologic isolation). The uppermost unit is returning to its pre-milling, mainly unsaturated state. The unit that contains the contaminated water is not a ground water resource because it qualifies as Class III (limited use) based on limited yield. Ground water in the uppermost unit is currently not used and is not anticipated to be used as a ground water resource. The nearby San Juan River and a converted oil exploration well provide all of the water needs for the area. There are no current threats to human health or livestock; and, because the zone of contamination does not represent a ground water resource, none are anticipated in the future. There are, however, seeps where contaminated water is exposed at land surface. The seeps create potential exposure pathways for plants and wildlife. It is not known at this time if there is a risk to the environment. Additional investigations are needed and are described in this document to confirm the presence or absence of potential environmental risks. Additional hydrogeologic investigations are not required. The proposed ground water compliance strategy for the site is no remediation, because the ground water in the uppermost aquifer (which is also the zone of contamination) qualifies for supplemental standards based on Class III, limited yield, and because there are no threats to human health. Domestic and agricultural water is pumped from a deeper aquifer that is isolated from the contaminated zone.

5140 (DOE/AL/62350–167) **Annual report on the U.S. Department of Energy's Cultural Resource Activities at Colorado UMTRA Project Sites for October 1993 through September 1994.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003912. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the results of cultural resource activities conducted by the U.S. Department of Energy (DOE) at Uranium Mill Tailings Remedial Action (UMTRA) Project sites in Colorado for the period of October 1, 1993, through September 30, 1994. The UMTRA Project is a cooperative (state and federal) program mandated by the Uranium Mill Tailings Radiation Control Act, Public Law 95-604 (42 USC §7901 et seq.). This law requires the timely cleanup of 24 inactive uranium mill tailings sites throughout the United States. Nine of these inactive uranium mill tailings sites are in Colorado at Durango, Grand Junction, Gunnison, Maybell, Naturita, Rifle, and Slick Rock. On December 6, 1984, the DOE, Advisory Council on Historic Preservation, and Colorado State Historic Preservation Officer (SHPO) entered into a programmatic memorandum of agreement (PMOA) (DOE, 1984). This PMOA specifies requirements for the DOE's fulfillment of its obligations under various state and federal regulations for the protection and preservation of cultural resources. This report fulfills the requirement for the DOE to provide the state of Colorado with an annual report on the cultural resource activities performed for all of the UMTRA Project sites in Colorado. This report is organized by UMTRA Project site. For each site, the general remedial action activities and cultural resource activities performed during the period of record are summarized. When known, the DOE's plans for future cultural resource activities at the site are summarized.

5141 (DOE/AL/62350–168) **Final report of the UMTRA Independent technical review of TAC audit programs.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Oct 1994. 76p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003913. Source: OSTI; NTIS; INIS; GPO Dep.

This report details the findings of an Independent Technical Review (ITR) of practices and procedures for the Uranium Mill Tailings Remedial Action (UMTRA) Project audit program. The audit program is conducted by Jacobs Engineering Group Inc., the Technical Assistance Contractor (TAC) for the UMTRA Project. The purpose of the ITR was to ensure that the TAC audit program is effective and is conducted efficiently. The ITR was conducted from May 16-20, 1994. A review team observed audit practices in the field, reviewed the TAC audit program's documentation, and discussed the program with TAC staff and management. The format of this report has been developed around EPA guidelines; they comprise most of the major section headings. Each section begins by identifying the criteria that the TAC program is measured against, then describing the approach used by the ITR team to measure each TAC audit program against the criteria. An assessment of each type of audit is then summarized for each component in the following order: Radiological audit summary; Health and safety audit summary; Environmental audit summary; Quality assurance audit summary.

5142 (DOE/AL/62350–T4) **UMTRA Project Administrative Files Collection Records Management Program.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003924. Source: OSTI; NTIS; INIS; GPO Dep.

The UPAFC Records Management Plan is based on the life cycle of a record - the evolution of a record from creation until final disposition. There are three major phases in the life cycle of a record: (1) creation and receipt, (2) maintenance and use, and (3) disposition. Accordingly, the Records Management Plan is structured to follow each of those phases. During each of the three phases, some kind of control is mandatory. The Records Management Plan establishes appropriate standards, policies, and procedures to ensure adequate control is always maintained. It includes a plan for records management, a plan for records management training activities, and a plan for auditing and appraising the program.

5143 (DOE/AL/62350–T6) **Comment and response document for the long-term surveillance plan and the completion report for the Lowman, Idaho, disposal site.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003926. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains comments, maps, ground water monitoring data, deeding information for remedial action on mill tailings at the Lowman, Idaho UMTRA site.

5144 (DOE/AN/ACNT–94C, pp. 8-12) **Technical issues in interim plutonium storage.** Martz, J.C. (Los Alamos National Lab., NM (United States)); Haschke, J.M.; Bryson, M.C. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

An unprecedented quantity of excess plutonium will have to be managed when large numbers of nuclear weapons are retired. Surplus materials from production and reprocessing operations will

also add to the amount of concentrated plutonium requiring safe and secure storage. This material will require interim storage for a considerable length of time until a method is chosen for ultimate disposition. Los Alamos National Laboratory, under programs supported by the DOE Office of Defense Programs, Office of Nuclear Energy, and Office of Nonproliferation and National Security, is assessing the technical issues of interim storage to provide a basis for addressing the political and economic issues involved. Here we discuss the merits of alternative storage approaches and present a qualitative ranking of material forms and options.

5145 (DOE/AN/ACNT–94C, pp. 13-16) **Project Stage Right: A solution for interim plutonium-pit storage.** Morse, W.D. (Sandia National Labs., Albuquerque, NM (United States)); Caskey, B.C.; Martin, F.P.; Wunderlin, F.K.; Mitchell, D.J.; Marlow, K.W.; Scott, H.L.; Muyshondt, G.P. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

The U.S. dismantlement program generates a significant quantity of weapon plutonium pits that must be stored safely and securely for an interim period. Pending a decision on a permanent storage site and method, the pits will be temporarily stored (staged) at the DOE Pantex Plant near Amarillo, Texas, using a multilayer configuration in existing magazines. Project State Right is providing a systems engineering solution to address personnel radiation exposure, material control and accountability, and safety-related issues.

5146 (DOE/AN/ACNT–94C, pp. 17-19) **Hazard-separation system for dismantlement of nuclear weapon components.** Lutz, J.D. (Sandia National Labs., Albuquerque, NM (United States)). USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

To enhance DOE's capability to effectively dismantle and dispose of weapon component materials, Sandia National Laboratories is developing a hazard-separation system (HSS). Its purpose is to provide an improved means for separating nuclear weapon components into readily disposable waste streams and nonhazardous recyclable materials. The system emphasizes regulatory compliance and maximizes the recovery and recycling of materials.

5147 (DOE/AN/ACNT–94C, pp. 20-21) **Shielding requirements for transporting nuclear weapons under dismantlement.** Hansen, L.F. (Lawrence Livermore National Lab., CA (United States)). USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

During nuclear-weapon dismantlement some of the weapons presently at storage facilities will be disassembled. The transport of nuclear weapons to disassembly plants and the subsequent transport of their components to storage facilities must comply with stringent DOE federal regulations. Among these regulations are requirements that calculations of the neutron and photon dose rates for the package and a criticality evaluation be performed before any shipment. Lawrence Livermore National Laboratory is participating in the design, certification, and documentation of containers to be used for U.S. transport of weapon components.

5148 (DOE/AN/ACNT–94C, pp. 22-23) **Plutonium identification with the Scout analyzer.** Rowland, M.S. (Lawrence Livermore National Lab., CA (United States)). USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

The commercially available Scout analyzer is part of a system that provides an automated capability to identify the existence of plutonium inside a storage container. Though the confirmation of plutonium is insufficient to identify an inspected article as a pit, it is a significant and necessary step toward this goal. It is achievable quickly using available equipment, and can be accomplished without compromising sensitive information. Components added to the Scout analyzer to form the measurement system include technologies specifically tailored to the peculiarities of measuring nuclear weapon materials.

5149 (DOE/AN/ACNT–94C, pp. 41-43) **Network technology for safeguards applications.** Johnson, C.S. (Sandia National Labs., Albuquerque, NM (United States)). USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

A flexible technology is now available to design sensor and control networks based on a protocol embedded in an intelligent communications processor. The flexibility allows a system designer and/or a technical installer to make appropriate tradeoffs between simplicity, functionality, and cost in the design of network nodes and their installation. This is particularly relevant to the safeguards network that will support weapons dismantlement activities.

5150 (DOE/EA–0978) **Sludge stabilization at the Plutonium Finishing Plant, Hanford Site, Richland, Washington.** Department of Energy, Washington, DC (United States). Div. of Electric Energy Systems. Oct 1994. 96p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004414. Source: OSTI; NTIS; INIS; GPO Dep.

This Environmental Assessment evaluates the proposed action to operate two laboratory-size muffle furnaces in glovebox HC-21C, located in the Plutonium Finishing Plant (PFP), Hanford Site, Richland, Washington. The muffle furnaces would be used to stabilize chemically reactive sludges that contain approximately 25 kilograms (55 pounds) of plutonium by heating to approximately 500 to 1000°C (900 to 1800°F). The resulting stable powder, mostly plutonium oxide with impurities, would be stored in the PFP vaults. The presence of chemically reactive plutonium-bearing sludges in the process gloveboxes poses a risk to workers from radiation exposure and limits the availability of storage space for future plant cleanup. Therefore, there is a need to stabilize the material into a form suitable for long-term storage. This proposed action would be an interim action, which would take place prior to completion of an Environmental Impact Statement for the PFP which would evaluate stabilization of all plutonium-bearing materials and cleanout of the facility. However, only 10 percent of the total quantity of plutonium in reactive materials is in the sludges, so this action will not limit the choice of reasonable alternatives or prejudice the Record of Decision of the Plutonium Finishing Plant Environmental Impact Statement.

5151 (DOE/EIS–0082-S) **Supplemental environmental impact statement - defense waste processing facility.** USDOE Savannah River Operations Office, Aiken, SC (United States). Nov 1994. 533p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004413. Source: OSTI; NTIS; INIS; GPO Dep.

This document supplements the Final Environmental Impact Statement (EIS) DOE Issued in 1982 (DOE/EIS-0082) to construct and operate the Defense Waste Processing Facility (DWPF) at the Savannah River Site (SRS), a major DOE installation in southwestern South Carolina. That EIS supported the decision to construct and operate the DWPF to immobilize high-level waste generated as a result of nuclear materials processing at SRS. The DWPF would use a vitrification process to incorporate the radioactive waste into borosilicate glass and seal it in stainless steel canisters for eventual disposal at a permanent geologic repository. The DWPF is now mostly constructed and nearly ready for full operation. However, DOE has made design changes to the DWPF since the 1982 EIS to improve efficiency and safety of the facility. Each of these modifications was subjected to appropriate NEPA review. The purpose of this Supplemental EIS is to assist DOE in deciding whether and how to proceed with operation of the DWPF as modified since 1982 while ensuring appropriate consideration of potential environmental effects. In this document, DOE assesses the potential environmental impacts of completing and operating the DWPF in light of these design changes, examines the impact

of alternatives, and identifies potential actions to be taken to reduce adverse impacts. Evaluations of impacts on water quality, air quality, ecological systems, land use, geologic resources, cultural resources, socioeconomics, and health and safety of onsite workers and the public are included in the assessment.

5152 (DOE/LLW–205) **1993 State-by-state assessment of low-level radioactive wastes received at commercial disposal sites.** Fuchs, R.L. Idaho National Engineering Lab., Idaho Falls, ID (United States). Sep 1994. 138p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE95003309. Source: OSTI; NTIS; INIS; GPO Dep.

Each year the National Low-Level Waste Management Program publishes a state-by-state assessment report. This report provides both national and state-specific disposal data on low-level radioactive waste commercially disposed in the United States. Data in this report are categorized according to disposal site, generator category, waste class, volumes, and radionuclide activity. Included in this report are tables showing the distribution of waste by state for 1993 and a comparison of waste volumes and radioactivity by state for 1989 through 1993; also included is a list of all commercial nuclear power reactors in the United States as of December 31, 1993. This report distinguishes between low-level radioactive waste shipped directly for disposal by generators and waste that was handled by an intermediary, a reporting change introduced in the 1988 state-by-state report.

5153 (DOE/NE/44139–55) **Low-level liquid waste treatment system start-up.** Baker, M.N.; Gessner, R.F. West Valley Nuclear Services Co., Inc., West Valley, NY (United States). Jul 1989. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-81NE44139. Order Number DE95004254. Source: OSTI; NTIS; GPO Dep.

Following removal of Cs-137 by ion exchange in the Supernatant Treatment System immediately upstream, the radioactive liquid waste is volume-reduced by evaporation. Trace amounts of Cs-137 in the resulting distillate are removed by ion exchange, then the distillate is discharged to the existing plant water treatment system. The concentrated product, 37 to 41 percent solids (by weight), is encapsulated in cement, producing a stable low-level waste form. This report provides a summary of work performed to test the Liquid Waste Treatment System following construction turnover and prior to radioactive operation. All mechanical and electrical components, piping, valves, pumps, tanks, controls, and instrumentation required to operate the system were tested; first with water, then with simulated waste. Subsystems (individual tanks, pumps, and control loops) were tested individually, then as a complete system. Finally, the system began a controlled start-up phase, which included the first four months of radioactive operation. Components were tested for operability then for performance data to verify the system's ability to produce an acceptable waste form at design feed rates.

5154 (DOE/NE/44139–64) **West Valley Demonstration Project vitrification process equipment Functional and Checkout Testing of Systems (FACTS).** Carl, D.E.; Paul, J.; Foran, J.M.; Brooks, R. West Valley Nuclear Services Co., Inc., West Valley, NY (United States). 30 Sep 1990. 104p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-81NE44139. Order Number DE95004252. Source: OSTI; NTIS; INIS; GPO Dep.

The Vitrification Facility (VF) at the West Valley Demonstration Project was designed to convert stored radioactive waste into a stable glass for disposal in a federal repository. The Functional and Checkout Testing of Systems (FACTS) program was conducted from 1984 to 1989. During this time new equipment and processes were developed, installed, and implemented. Thirty-seven FACTS tests were conducted, and approximately 150,000 kg of glass were made by using nonradioactive materials to simulate the radioactive waste. By contrast, the planned radioactive operation is expected to produce approximately 500,000 kg of glass. The FACTS program demonstrated the effectiveness of equipment and procedures in the vitrification system, and the ability of the VF to produce quality glass on schedule. FACTS testing also provided data to validate the WVNS waste glass qualification method and verify that the product glass would meet federal repository acceptance requirements. The system was built and performed to standards which would have enabled it to be used in radioactive service. As a result, much of the VF tested, such as the civil construction, feed mixing and holding vessels, and the off-gas scrubber, will be converted for radioactive operation. The melter was still in good condition after being at temperature for fifty-eight of the sixty months of FACTS. However, the melter exceeded its recommended design life and will be replaced with a similar melter. Components that were not designed for remote operation and maintenance will be replaced with remote-use items. The FACTS testing was accomplished with no significant worker injury or environmental releases. During the last FACTS run, the VF processes approximated the remote-handling system that will be used in radioactive operations. Following this run the VF was disassembled for conversion to a radioactive process. Functional and checkout testing of new components will be performed prior to radioactive operation.

5155 (DOE/NE/44139–69) **High-level waste tank modifications, installation of mobilization equipment/check out.** Schiffhauer, M.A.; Thompson, S.C. West Valley Nuclear Services Co., Inc., West Valley, NY (United States). 31 Aug 1992. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-81NE44139. Order Number DE95004253. Source: OSTI; NTIS; INIS; GPO Dep.

PUREX high-level waste (HLW) is contained at the West Valley Demonstration Project (WVDP) in an underground carbon-steel storage tank. The HLW consists of a precipitated sludge and an alkaline supernate. This report describes the system that the WVDP has developed and implemented to resuspend and wash the HLW sludge from the tank. The report discusses Sludge Mobilization and Wash System (SMWS) equipment design, installation, and testing. The storage tank required modifications to accommodate the SMWS. These modifications are discussed as well.

5156 (DOE/NV/11417–6) **Great Basin Paleoenvironmental Studies Project: Technical progress report, Second quarter (Year 2), September–December 1994.** Nevada Univ., Reno, NV (United States). Desert Research Inst. [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC08-93NV11417. Order Number DE95005122. Source: OSTI; NTIS; GPO Dep.

The paleobiotic and geomorphic records are being examined for the local and regional impact of past climates to assess Yucca Mountain's suitability as a high-level nuclear waste repository. In particular these data are being used to provide estimates of the timing, duration and extremes of past periods of moister climate for use in hydrological models of local and regional recharge that are being formulated by USGS and other hydrologists for the Yucca Mountain area. The project includes botanical, faunal, and geomorphic components that will be integrated to accomplish this goal.

5157 (DOE/OR–01-1273/V1-D1) **Remedial investigation report on Bear Creek Valley Operable Unit 2 (Rust Spoil Area, Spoil Area 1, and SY-200 Yard) at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee. Volume 1, Main text.** Oak Ridge Y-12 Plant, TN (United States); Science Applications International Corp., Oak Ridge, TN (United States). Aug 1994. 510p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (Y/ER–182/V1-D1). Order Number DE95002066. Source: OSTI; NTIS; INIS; GPO Dep.

The enactment of the Resource Conservation and Recovery Act (RCRA) in 1976 and the Hazardous and Solid Waste Amendments (HSWA) to RCRA in 1984 created management requirements for hazardous waste facilities. The facilities within the Oak Ridge Reservation (ORR) were in the process of meeting the RCRA requirements when the ORR was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) on November 21, 1989. Under RCRA, the actions typically follow the RCRA Facility Assessment/RCRA Facility Investigation (RFI)/Corrective Measures Study (CMS)/Corrective Measures Implementation process. Under CERCLA, the actions follow the preliminary assessment/site investigation/Remedial Investigation (RI)/Feasibility Study (FS)/Remedial Design/Remedial Action process. This document incorporates requirements under both RCRA and CERCLA in the form of an RI report for the characterization of Bear Creek Valley (BCV) Operable Unit (OU) 2.

5158 (DOE/OSTI–3406-(Suppl.3)(Add.3)) **Yucca Mountain Site Characterization Project bibliography, January–June 1993. An update.** USDOE Office of Scientific and Technical Information, Oak Ridge, TN (United States). Nov 1993. 31p. Sponsored by USDOE, Washington, DC (United States). Order Number DE93015389. Source: OSTI; NTIS; INIS; GPO Dep.

Following a reorganization of the Office of Civilian Radioactive Waste Management in 1990, the Yucca Mountain Project was renamed Yucca Mountain Site Characterization Project. The title of this bibliography was also changed to Yucca Mountain Site Characterization Project Bibliography. Prior to August 5, 1988, this project was called the Nevada Nuclear Waste Storage Investigations. This bibliography contains information on this ongoing project that was added to the Department of Energy's Energy Science and Technology Database from January 1, 1993, through June 30, 1993. The bibliography is categorized by principal project participating organization. Participant-sponsored subcontractor reports, papers, and articles are included in the sponsoring organization's list. Another section contains information about publications on the Energy Science and Technology Database that were not sponsored by the project but have some relevance to it.

5159 (DOE/RL–89-28-Rev.2) **216-B-3 expansion ponds closure plan.** Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 938p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004360. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes the activities for clean closure under the Resource Conservation and Recovery Act of 1976 (RCRA) of the 216-B-3 Expansion Ponds. The 216-B-3 Expansion Ponds are operated by the US Department of Energy, Richland Operations Office (DOE-RL) and co-operated by Westinghouse Hanford Company (Westinghouse Hanford). The 216-B-3 Expansion Ponds consists of a series of three earthen, unlined, interconnected ponds that receive waste water from various 200 East Area operating facilities. The 3A, 3B, and 3C ponds are referred to as Expansion Ponds because they expanded the capability of the B Pond System. Waste water (primarily cooling water, steam condensate, and sanitary water) from various 200 East Area facilities is discharged to the Bypass pipe (Project X-009). Water discharged to the Bypass pipe flows directly into the 216-B-3C Pond. The ponds were operated in a cascade mode, where the Main Pond overflowed into the 3A Pond and the 3A Pond overflowed into the 3C Pond. The 3B Pond has not received waste water since May 1985; however, when in operation, the 3B Pond received overflow from the 3A Pond. In the past, waste water discharges to the Expansion Ponds had the potential to have contained mixed waste (radioactive waste and dangerous waste). The radioactive portion of mixed waste has been interpreted by the US Department of Energy (DOE) to be regulated under the Atomic Energy Act of 1954; the dangerous waste portion of mixed waste is regulated under RCRA.

5160 (DOE/RL–94-29) **State waste discharge permit application: 200 Area Treated Effluent Disposal Facility (Project W-049H).** Westinghouse Hanford Co., Richland, WA (United States). Aug 1994. 170p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003269. Source: OSTI; NTIS; INIS; GPO Dep.

As part of the original Hanford Federal Facility Agreement and Concent Order negotiations, US DOE, US EPA and the Washington State Department of Ecology agreed that liquid effluent discharges to the ground to the Hanford Site are subject to permitting in the State Waste Discharge Permit Program (SWDP). This document constitutes the SWDP Application for the 200 Area TEDF stream which includes the following streams discharged into the area: Plutonium Finishing Plant waste water; 222-S laboratory Complex waste water; T Plant waste water; 284-W Power Plant waste water; PUREX chemical Sewer; B Plant chemical sewer, process condensate, steam condensate; 242-A-81 Water Services waste water.

5161 (DOE/RW–0449) **FY1993 annual report to Congress.** USDOE Office of Civilian Radioactive Waste Management, Washington, DC (United States). Sep 1994. 130p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003292. Source: OSTI; NTIS; INIS; GPO Dep.

As established by the Nuclear Waste Policy Act of 1982, as amended, the United States Department of Energy's Office of Civilian Radioactive Waste Management is responsible for managing and disposing of the Nation's spent nuclear fuel from civilian nuclear power reactors and high-level radioactive waste from defense activities. The program will provide leadership in developing and implementing strategies that assure the health and safety of the public and workers, protect the environment, and merit public confidence, in an economically viable manner. To accomplish the program's mission, we are developing a waste management system culminating in a geologic repository for permanent disposal deep beneath the surface of the earth. Our goals include: (1) determining whether Yucca Mountain, Nevada, designated by the Nuclear Waste Policy Amendments Act of 1987 as the only site currently to be evaluated, is suitable for a geologic repository; (2) resolving the issue of acceptance of spent fuel from nuclear utilities in 1998; (3) developing more effective working relationships with external parties who have an interest in the waste disposal mission; and (4) establishing a new funding mechanism that will permit efficient and effective execution of our mission and achievement of our goals. This report contains details of the program's accomplishments and activities over the past fiscal year and the audited financial statements for the Nuclear Waste Fund.

5162 (ENRESA–06/94) **Ecology of aquatic systems in El Cabril (ES).** Garcia Novo, F. (Departamento de Ecologia, Facultad de Biologia, Universidad de Sevilla, Sevilla (Spain)); Bautista Gallego, J.; Escot Muoz, C.; Mellado Alvarez, E.; Rodriguez Ruiz, A.; Encina Encina, L.; Prenda Marin, J.; Diaz Guervos, P. No corporate text available. 1994. 141p. (In Spanish). Order Number DE95721638. Source: OSTI; NTIS; INIS.

This report presents the ecology of rivers through the Cabril area (Spain), where the radioactive wastes are stored.

5163 (ENRESA–07/94) **Depth geologic storage of high-level radioactive wastes.** No corporate text available. 1994. 58p. (In Spanish). Order Number DE95721636. Source: OSTI; NTIS; INIS.

This report presents the radioactive wastes and its disposal in granite rocks and (saline) formations. Characteristics, safety and cost of repositories are presented.

5164 (HW–45747) **Routine 107 basin inlet samples.** Reid, D.L. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 25 Aug 1956. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95003375. Source: OSTI; NTIS; GPO Dep.

This document consists entirely of tables giving a chemical analysis of reactor effluent water samples (Routine 107 Basin Inlet samples).

5165 (INIS-mf–15027) **Comparison of geochemical computer programs and expansion of the thermodynamic data base for modelling high-saliniferous solutions. Phase 1. Final report.** Voigt, W.; Henneberg, E. Technische Univ. Bergakademie Freiberg (Germany). Fachbereich Chemie. 22 May 1993. 74p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 02E8361. Order Number DE95726921. Source: OSTI; NTIS (US Sales Only); INIS.

The experiments were designed to contribute to expand the thermodynamic data base for temperatures of up to 200 C for the modelling of heat producing wastes (ultimate disposal of radioactive wastes up to 200 C) in polyhalite-bearing salt domes. To describe the activities of high-saliniferous solutions in salt domes, the ion interaction model of PITZER is used. Contact of such solutions with polyhalite leads to solutions of the system of oceanic salts Na^+, K^+, Mg^{2+}, Ca^{2+}/Cl^-, SO_4^{2-}-H_2O. For temperatures of up to 100 C, sufficient studies of solubility equilibriums are available in order to be able to satisfactorily describe or precalculate, by means of the PITZER-approach, the solution and formation conditions of mineral salt paragenesis on a thermodynamic basis, for the majority of the problems. (orig.)

5166 (INIS-mf–15076) **Radiation effects in rock salt. A status report.** Gies, H.; Hild, W.; Kuehle, T.; Moenig, J. GSF - Forschungszentrum fuer Umwelt und Gesundheit GmbH, Braunschweig (Germany). Inst. fuer Tieflagerung. 1994. 163p. Translated from German: Strahleneffekte im Steinsalz - Statusbericht. GSF-report 9/93. Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT KWA5901; Foerderkennzeichen BMFT 02E8532 Order Number DE95731872. Source: OSTI; NTIS (US Sales Only); INIS.

Knowledge of the irradiation defects and the accompanying energy storage in rock salt resulting from the absorption of ionizing radiation emitted by vitrified high level radioactive waste (HLW) disposed off in geological rock salt formations in an important prerequisite for a realistic assessment of possible consequences. Based on a critical review of the scientific status this report attempts to evaluate whether the available database is satisfactory and sufficiently reliable for the performance of such an assessment. Apart from a brief description of the radiation- and temperature-conditions prevailing in a HLW-repository a detailed presentation is given of both the interaction of radiation with rock salt and the theories and models developed for their quantification. In a simplified way radiation damage is represented by the formation of colloidal sodium and elementary chlorine. The basic phenomena are understood. At low radiation doses mainly F- and H-centers are formed (induction phase). Increasing irradiation dose results in a second phase exhibiting a linear relationship between irradiation defects and dose. At still higher doses a saturation in the formation of irradiation defects can occur under specific conditions. Various parameters exert a different influence on these three phases. A detailed description and evaluation is presented of the experimental results and the analytical methods applied. The dependence of the irradiation defect formation on different parameters is checked based on calculation models and, if possible, on experimental results. A final assessment as to the amount of both irradiation defect formation and energy storage in a final repository is, as yet, not possible. Estimates result in values below 400 J/g or less than 3.5 molar percent colloidal sodium, respectively. *** Abstract Truncated ***.

5167 (JAERI-M–94-019, pp. 152-153) **Request of nuclear data file for study of new application of transmutation.** Iwasaki, Tomohiko (Tohoku Univ., Sendai (Japan). Faculty of Engineering). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

Following two topics concerning on transmutation of hazardous materials are described. (1) Transmutation of TRU wastes in higher flux field. (2) Transmutation of chemical hazardous materials. The most important base-data for the transmutation of hazardous materials is nuclear data. However, the nuclear data for the nuclides of hazardous materials are not contained in JENDL-3. The nuclear data containing minor or rare isotopes are required. (author).

5168 (JAERI-Research–94-028) **Safety and sensitivity analyses of a generic geologic disposal system for high-level radioactive waste.** Kimura, Hideo (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Takahashi, Tomoyuki; Shima, Shigeki; Matsuzuru, Hideo. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1994. 58p. Order Number DE95737273. Source: OSTI; NTIS; INIS.

This report describes safety and sensitivity analyses of a generic geologic disposal system for HLW, using a GSRW code and an automated sensitivity analysis methodology based on the Differential Algebra. An exposure scenario considered here is based on a normal evolution scenario which excludes events attributable to probabilistic alterations in the environment. The results of sensitivity analyses indicate that parameters related to a homogeneous rock surrounding a disposal facility have higher sensitivities to the output analyzed here than those of a fractured zone and engineered barriers. The sensitivity analysis methodology provides technical information which might be bases for the optimization of design of the disposal facility. Safety analyses were performed on the reference disposal system which involve HLW in amounts corresponding to 16,000 MTU of spent fuels. The individual dose equivalent due to the exposure pathway ingesting drinking water was calculated using both the conservative and realistic values of geochemical parameters. In both cases, the committed dose equivalent evaluated here is the order of 10^{-7}Sv, and thus geologic disposal of HLW may be feasible if the disposal conditions assumed here remain unchanged throughout the periods assessed here. (author).

5169 (Juel–2883) **Research project MAW and HTR fuel element test storage in boreholes (MHV project). Emplacement and borehole sealing techniques (EBT part-project). Final report on project phase October 1, 1989 - December 31, 1992.** Barnert, E.; Bruecher, H.; Kroth, K. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Sicherheitsforschung und Reaktortechnik. Mar 1994. 89p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT KWA5302B. Order Number DE95726855. Source: OSTI; NTIS (US Sales Only); INIS.

The paper documents the working results of the third project phase from 1.10.89 to 31.12.92. At the beginning, the atmosphere in the repository borehole during the operational and post-operational phase is described. The borehole atmosphere is decisively influenced by gas and humidity releases from the waste forms and the solid rock salt, by the propagation of gases in the unfilled part of the borehole and in the part backfilled with salt grit, and by the permiabilities of the borehole lock and the solid bedrock. Hydrogen gas may be oxidized by an addition agent. The reference concept of borehole storage is the embedding of the waste forms in salt grit. The salt grit backfill required therefore is characterized, and pressure distribution in the backfill during storing of the forms in the borehole is modelled. Finally the flame extinguishing effect of salt grit is described. Safety considerations and a draft concept of a borehole backfill container complete the work of this project phase. (orig./HP)

5170 (Juel–2896) **Selenium release from iodine filters in the event of brine ingress into a repository.** Ullrich, W.; Riedel, H.J. Forschungszentrum Juelich GmbH (Germany). Inst. fuer Sicherheitsforschung und Reaktortechnik. Apr 1994. 32p. (In German). Order Number DE95726741. Source: OSTI; NTIS (US Sales Only); INIS.

In the course of studies of reaction processes in the event of emergency brine ingress into a repository, the radionuclide Se-79 which also is relevant for long-term considerations (T 1/2=6,5x10^4 a) was included into the emergency studies. During higher temperature processes, such as dissolution steps and sealing processes of fission products in glass or ceramics for their ultimate disposal, selenium may be released. Metallic selenium for instance evaporates at about 680 C, and SeO_2 sublimates already at 315 C, and thus gets into the waste gas flow. Together with the also volatile iodine, that waste gas is purified by filters (AC 6120) impregnated with $AgNO_3$. Selenium is bonded to those iodine filters in the form of silverselenium compounds, for instance as Ag_2SeO_3 or Ag_2SeO_4, and is stored together with them. The behaviour of those filters charged with iodine and selenium, with regard to brines was studied assuming that they are stored in iron barrels and that therefore iron as a coreactant is available in the vicinity. (orig./HP)

5171 (KFK–5333) **Nuclear Research Center Karlsruhe, Institute of Nuclear Waste Management Technology. Progress report on research and development activities in 1993.** Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Nukleare Entsorgungstechnik. Mar 1994. 22p. (In German). Order Number DE95726740. Source: OSTI; NTIS (US Sales Only); INIS.

Priority subjects of the Institute of Nuclear Waste Management Technology' work in 1993 were: Corrosion studies of high burnup LWR fuel in interaction with brines; retention of Pu, A Np and Tc curing corrosion of the high-level radioactive glass R7T7; formation of hydrotalcite during corrosion of the simulated inactive glass R7Z7 in brines; chemical behaviour of redox sensitive elements in aqueous chloride-containing systems in the near range of repositories; corrosion studies of waste container materials; solid-liquid equilibriums of uranium compounds in concentrated brines; thermodynamics of Np(V) in concentrated brines; quantification of radiation-chemical effects in the near range of repositories with a view to redox state change and gas formation; laser-spectroscopic speciation and thermodynamics of Cm(III) in highly concentrated

brines; development of laser-spectroscopic speciation methods; radio-chemical and chemical analyses of radioactive samples; theoretical work on the development of a sorption model; studies of the compaction behaviour of filling material; thermomechanic effects of an HAW storage site on neighbouring inhomogeneities in the salt rock; optimization of vitrification technologies; structural studies of HAW model glasses. (orig./HP)

5172 (KTM/E-C--42) **Report on the spent fuel management of the Loviisa nuclear power plant.** Sahrakorpi, Y.; Immonen, S.; Haltia, O. (eds.). Ministry of Trade and Industry, Helsinki (Finland). Energy Dept. Mar 1994. 47p. (In Finnish). Order Number DE95611244. Source: OSTI; NTIS; INIS.

In the report such amendments to the relevant laws, regulations and administrative decisions are drafted as would permit Finland to achieve the goal set by the Council of State in its energy policy statement to the Parliament in the autumn 1993, i.e. that Finland would, in future, have to assume the responsibility for all nuclear wastes produced in its own territory. Also was studied what effects the new practice would have on the waste management safety and on the economy of the nation and the companies involved. the changed operational policy would in practice be limited to concern the Loviisa NPP whose spent nuclear fuel has so far been reexported to Russia, the town of Chelyabinsk for reprocessing. Termination of this practice would entail a need to dispose of all spent fuel permanently in Finnish bedrock. (1 fig., 2 tabs.).

5173 (LA-SUB--94-34) **Preparation for kinetic measurements on the silicates of the Yucca Mountain potential repository. [Final report], June 15, 1993--September 30, 1993.** Los Alamos National Lab., NM (United States); Pennsylvania State Univ., University Park, PA (United States). Ore Deposits Research Section. [1993]. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94017049. Source: OSTI; NTIS; INIS; GPO Dep.

Part 1, "The Preparation of Clinoptilolite, Mordenite and Analcime," summarized progress made during the contract period on preparing Na-end member clinoptilolite, mordenite, and analcime. The objective is to use the prepared zeolites to determine rates of dissolution and precipitation in laboratory flow-through systems in both this lab to 350 C and by the geochemists at Yale University to about 80 C. Because clinoptilolite represents the most complicated phase of these three zeolites and it is most abundant at Yucca Mountain, the authors have concentrated most of their efforts on its preparation. They have collected, high-concentration natural clinoptilolite samples. A hindered settling technique that takes advantage of the relatively low specific gravity of clinoptilolite coupled with ultrasonic cleaning in deionized water has been employed. This material is now a mixed Na-K zeolite which must then be converted to the pure Na-end member composition. In Part 2, "Draft Manuscript on the Heterogeneous Kinetics of Cristobalite," experiments on the rates of reactions of dissolution and precipitation of cristobalite were carried at 150--300 C. Results show that cristobalite may precipitate from hydrothermal solution if the concentration of $Si(OH)_4$ exceeds that at quartz saturation and is less than that of amorphous silica saturation and if there are cristobalite nuclei present. Such nuclei may occur where there has been devitrification of volcanic glasses, for example. Cristobalite has refused to crystallize in the absence of such nuclei. Steady state concentrations were reached experimentally after starting at 150 ° with initially supersaturated solutions and at 200 C starting with either supersaturated or undersaturated solutions. From the steady state conditions, equilibrium constants can be derived.

5174 (LA-SUB--94-154) **An assessment of Microtox™ as a biomonitoring tool for whole effluent testing for Los Alamos National Laboratory.** Zachritz, W.H. II (New Mexico State Univ., Las Cruces, NM (United States)); Morrow, J. Los Alamos National Lab., NM (United States); New Mexico State Univ., Las Cruces, NM (United States). 13 Jun 1994. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003457. Source: OSTI; NTIS; INIS; GPO Dep.

Los Alamos National Laboratory (LANL) has special discharge problems relating to potential radioactive content of the effluent discharge waters. Because of this all testing must be performed on-site and results must be rapidly determined. There is a need to examine the development of a real-time procedure for effluent biomonitoring to met these site limitations. The Microtox™ unit for toxicity testing is a microbially-based test system that shows great promise to be used for WET testing. The overall goal of this study is to develop an acceptable protocol for operational biomonitoring using the Microtox ™ toxicity test for LANL. The specific objectives include: development of an appropriate toxicity testing protocol using the Microtox™ toxicity test for whole effluent toxicity testing and evaluation of the protocol based on factors such as sensitivity, response time, cost of analysis, and simplicity of operation.

5175 (LA-UR--94-228) **Phase report 1C, TA-21 operable unit RCRA Facility Investigation, Outfalls Investigation.** Los Alamos National Lab., NM (United States). 28 Feb 1994. 610p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003752. Source: OSTI; NTIS; INIS; GPO Dep.

This phase report summarizes the results of field investigations conducted in 1992 at Technical Area 21 of Los Alamos National Laboratory, as prescribed by the RCRA Facility Investigation work plan for the Technical Area 21 operable unit (also known as OU 1106). This phase report is the last part of a three-part phase report describing the results of field work conducted in 1992 at this operable unit. Phase Report IA, issued on I4 June I993, summarized site geologic characterization activities. Phase report 1B, issued on 28 January 1994, included an assessment of site-wide surface soil background, airborne emissions deposition, and contamination in the locations of two former air filtration buildings. The investigations assessed in Phase Report 1C include field radiation surveys and surface and near-surface sampling to characterize potential contamination at 25 outfalls and septic systems listed as SWMUs in the RFI work plan. Based on the RFI data, it is recommended that no further action is warranted for 8 SWMUs and further action is recommended for 3 SWMUs addressed in this phase report. For 14 SWMUs which represent no immediate threat to human health or environment, deferral of further action/no further action decisions is recommended until outstanding analytical data are received, sampling of adjacent SWMUs is completed, or decisions are made about the baseline risk assessment approach.

5176 (LA-UR--94-1507) **Radioactive Liquid Waste Treatment Facility: Environmental Information Document.** Haagenstad, H.T. (Los Alamos National Lab., NM (United States)); Gonzales, G.; Suazo, I.L. Los Alamos National Lab., NM (United States); ICF Kaiser Engineers, Inc., Oakland, CA (United States). Nov 1993. 115p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003618. Source: OSTI; NTIS; INIS; GPO Dep.

At Los Alamos National Laboratory (LANL), the treatment of radioactive liquid waste is an integral function of the LANL mission: to assure U.S. military deterrence capability through nuclear weapons technology. As part of this mission, LANL conducts nuclear materials research and development (R&D) activities. These activities generate radioactive liquid waste that must be handled in a manner to ensure protection of workers, the public, and the environment. Radioactive liquid waste currently generated at LANL is treated at the Radioactive Liquid Waste Treatment Facility (RLWTF), located at Technical Area (TA)-50. The RLWTF is 30 years old and nearing the end of its useful design life. The facility was designed at a time when environmental requirements, as well as more effective treatment technologies, were not inherent in engineering design criteria. The evolution of engineering design criteria has resulted in the older technology becoming less effective in treating radioactive liquid wastestreams in accordance with current National Pollutant Discharge Elimination System (NPDES) and Department of Energy (DOE) regulatory requirements. Therefore, to support ongoing R&D programs pertinent to its mission, LANL is in need of capabilities to efficiently treat radioactive liquid waste onsite or to transport the waste off site for treatment and/or disposal. The purpose of the EID is to provide the technical baseline information for subsequent preparation of an Environmental Impact Statement (EIS) for the RLWTF. This EID addresses the proposed action and alternatives for meeting the purpose and need for agency action.

5177 (LA-UR--94-1509) **Biological Information Document, Radioactive Liquid Waste Treatment Facility.** Biggs, J. Los

Alamos National Lab., NM (United States). [1995]. 183p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003617. Source: OSTI; NTIS; INIS; GPO Dep.

This document is intended to act as a baseline source material for risk assessments which can be used in Environmental Assessments and Environmental Impact Statements. The current Radioactive Liquid Waste Treatment Facility (RLWTF) does not meet current General Design Criteria for Non-reactor Nuclear Facilities and could be shut down affecting several DOE programs. This Biological Information Document summarizes various biological studies that have been conducted in the vicinity of new Proposed RLWTF site and an Alternative site. The Proposed site is located on Mesita del Buey, a mess top, and the Alternative site is located in Mortandad Canyon. The Proposed Site is devoid of overstory species due to previous disturbance and is dominated by a mixture of grasses, forbs, and scattered low-growing shrubs. Vegetation immediately adjacent to the site is a pinyon-juniper woodland. The Mortandad canyon bottom overstory is dominated by ponderosa pine, willow, and rush. The south-facing slope was dominated by ponderosa pine, mountain mahogany, oak, and muhly. The north-facing slope is dominated by Douglas fir, ponderosa pine, and oak. Studies on wildlife species are limited in the vicinity of the proposed project and further studies will be necessary to accurately identify wildlife populations and to what extent they utilize the project area. Some information is provided on invertebrates, amphibians and reptiles, and small mammals. Additional species information from other nearby locations is discussed in detail. Habitat requirements exist in the project area for one federally threatened wildlife species, the peregrine falcon, and one federal candidate species, the spotted bat. However, based on surveys outside of the project area but in similar habitats, these species are not expected to occur in either the Proposed or Alternative RLWTF sites. Habitat Evaluation Procedures were used to evaluate ecological functioning in the project area.

5178 (LA-UR–94-1510) **Best available technology for the Los Alamos National Laboratory Radioactive Liquid Waste Treatment Facility.** Midkiff, W.S.; Romero, R.L.; Suazo, I.L.; Garcia, R.; Parsons, R.M. Los Alamos National Lab., NM (United States). 15 Oct 1993. 373p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003754. Source: OSTI; NTIS; INIS; GPO Dep.

The existing Los Alamos National Laboratory TA-50 liquid radioactive waste treatment plant RLWP has been in service for over thirty years, during this period many technical, regulatory, and processing changes have occurred. The existing facility can no longer comply with the demands and requirements for continued operation, and would not be able to comply with anticipated stringent future contaminant discharge limitations. Either a major upgrading or replacement of the existing facility is required. In order to assess the most appropriate means of providing an adequate facility to comply with predicted requirements for Ta-50, this Best Available Technology (BAT) Study was conducted to compare feasible technical and economic alternatives in order to define the most favorable technology configuration. This report consists of eleven sections. Section 1 provides a general introduction and background of the TA-50 operations and the basis for this study. Section 2 provides a technical discussion of the unit processes at TA-50 and several other comparable operations at other DOE sites. Section 3 addresses the evaluation and selection of appropriate treatment processes. Section 4 provides an analysis of environmental issues and concerns. Section 5 presents the rationale for the selection of preferred process configurations. Section 6 is the evaluation of operational issues. Section 7 addresses energy and resource use topics. Section 8 provides an economic analysis, and Section 9 summarizes the evaluation and the identification of the BAT. These sections are augmented by appendices. The report identifies the construction of a new radioactive liquid waste treatment facility as the BAT. Based on the information analyzed for this study, this option appears to provide the best combination of environmental compliance, operability, and economic value.

5179 (LA-UR–94-2839) **1993 Annual PCB Document for Los Alamos National Laboratory EPA Region VI, January 1, 1993 through December 31, 1993.** Wechsler, R.J.; Sandoval, T.M.; Bryant, D.E.; Hupke, L.; Esquibel, L. Los Alamos National Lab., NM (United States). [1995]. 206p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003753. Source: OSTI; NTIS; INIS; GPO Dep.

This document, the "1993 Annual PCB Document for Los Alamos National Laboratory" was prepared to fulffill the requirements of the federal PCB (Polychlorinated Biphenyl) regulation: 40 CFR 761 Subpart J General Records and Reports. The PCB Management Program at Los Alamos National Laboratory (LANL), Environmental Protection Group, compiled this 1993 Annual PCB Document. The overall format generally follows the sequence of the applicable regulations. Subsection 1.2 cross references those regulatory requirements with the applicable Document Section. The scope of this document also includes status summaries of various aspects of LANL's PCB Management Program. The intent of this approach to the Annual Document is to provide an overview of LANL's PCB Management Program and to increase the usefulness of this document as a management tool. Section 2.0, "Status of the PCB Management Program", discusses the use, generation of waste, and storage of PCBs at LANL. Section 3.0 is the 1993 Annual Document Log required by 761.180(a). This Section also discusses the PCB Management Program's policies for reporting under those regulatory requirements. Sections 4.0 and 5.0 contain the 1993 Annual Records for off-site and on-site disposal as required by 761.180(b). There is a tab for each manifest and its associated continuation sheets, receipt letters, and certificates of disposal.

5180 (LA-UR–94-3303) **Effect of natural organic materials on cadmium and neptunium sorption.** Kung, K.S.; Triay, I.R. Los Alamos National Lab., NM (United States). [1994]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409231–1: NEA workshop on binding models-organics, Bad Zurach (Switzerland), 14-16 Sep 1994). Order Number DE95000843. Source: OSTI; NTIS; INIS; GPO Dep.

In a batch sorption study of the effect of naturally occurring organic materials on the sorption of cadmium and neptunium on oxides and tuff surfaces, the model sorbents were synthetic goethite, boehmite, amorphous silicon oxides, and a crushed tuff material from Yucca Mountain, Nevada. An amino acid, 3-(3,4-dihydroxypheny)-DL-alanine (DOPA), and an aquatic-originated fulvic material, Nordic aquatic fulvic acid (NAFA), were used as model organic chemicals. Sorption isotherm results showed that DOPA sorption followed the order aluminum oxide > iron oxide > silicon oxide and that the amount of DOAP sorption for a given sorbent increased as the solution pH was raised. The sorption of cadmium and neptunium on the iron oxide was about ten times higher than that on the aluminum oxide. The sorption of cadmium and neptunium on natural tuff material was much lower than that on aluminum and iron oxides. The sorption of cadmium on iron and aluminum oxides was found to be influenced by the presence of DOPA, and increasing the amount of DOPA coating resulted in higher cadmium sorption on aluminum oxide. However, for iron oxide, cadmium sorption decreased with increasing DOPA concentration. The presence of the model organic materials DOPA and NAFA did not affect the sorption of neptunium on tuff material or on the iron and aluminum oxides. Spectroscopic results indicate that cadmium complexes strongly with DOPA. Therefore, the effect of the organic material, DOPA, on the cadmium sorption is readily observed. However, neptunium is possibly complexed weakly with organic material. Thus, DOPA and NAFA have little effect on neptunium sorption on all sorbents selected for study.

5181 (LA-UR–94-3662) **Independent technical review of the Pinellas Plant.** Los Alamos National Lab., NM (United States). Jul 1994. 132p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003709. Source: OSTI; NTIS; GPO Dep.

This report documents an Independent Technical Review (ITR) of facilities, organizations, plans, activities and various other elements required to successfully transition the Pinellas Plant from Defense Program (DP) funded operation to either community developed reuse or safe deactivation leading to decontamination and decommissioning (D&D). The review was conducted at the request of the

Department of Energy (DOE) Deputy Assistant Secretary for Facility Transition and Management (EM-60) and is a consensus of the nine member ITR Team.

5182 (LA-UR–94-3724) **Lessons learned from commercial experience with nuclear plant decontamination to safe storage.** Fischer, S.R.; Partain, W.L.; Sype, T. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941102–36: Winter meeting of the American Nuclear Society, Washington, DC (United States), 13-18 Nov 1994). Order Number DE95003719. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy (DOE) has successfully performed decontamination and decommissioning (D&D) on many production reactors it. DOE now has the challenge of performing D&D on a wide variety of other nuclear facilities. Because so many facilities are being closed, it is necessary to place many of them into a safe-storage status before conducting D&D-for perhaps as much as 20 yr. The challenge is to achieve this safe-storage condition in a cost-effective manner while remaining in compliance with applicable regulations. The DOE Office of Environmental Management, Office of Transition and Management, commissioned a lessons learned study of commercial experience with safe storage and transition to D&D. Although the majority of the commercial experience has been with reactors, many of the lessons learned presented in this paper are directly applicable to transitioning the DOE Weapons Complex.

5183 (LA-UR–94-3752) **Independent technical review, handbook.** Los Alamos National Lab., NM (United States). Feb 1994. 337p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003707. Source: OSTI; NTIS; INIS; GPO Dep.

Purpose Provide an independent engineering review of the major projects being funded by the Department of Energy, Office of Environmental Restoration and Waste Management. The independent engineering review will address questions of whether the engineering practice is sufficiently developed to a point where a major project can be executed without significant technical problems. The independent review will focus on questions related to: (1) Adequacy of development of the technical base of understanding; (2) Status of development and availability of technology among the various alternatives; (3) Status and availability of the industrial infrastructure to support project design, equipment fabrication, facility construction, and process and program/project operation; (4) Adequacy of the design effort to provide a sound foundation to support execution of project; (5) Ability of the organization to fully integrate the system, and direct, manage, and control the execution of a complex major project.

5184 (LA-UR–94-3784) **Design and construction of a new DC proton injector.** Schneider, J.D.; Stevens, R.B. Jr. Los Alamos National Lab., NM (United States). [1995]. 4p. Sponsored by Defense Nuclear Agency, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950110–15: 12. symposium on space nuclear power and propulsion, Albuquerque, NM (United States), 8-12 Jan 1995). Order Number DE95003688. Source: OSTI; NTIS (US Sales Only); GPO Dep.

During the past 14 months, an experimental team within the accelerator operations and technology division at Los Alamos National Laboratory has completed the design, construction and partial testing of a new, very promising cw (or DC) proton injector that should meet the needs of the Accelerator-Driven Transmutation Technologies (ADTT) programs. This ion injector incorporates much of the best available technology to provide an impressive compact and high-performance system.

5185 (LA-UR–94-3825) **Independent Technical ("Red Team") Reviews.** Thullen, P. (Los Alamos National Labs., NM (United States)); Bennett, D.R.; Kosiewicz, S.T.; Weaver, D.L. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941102–35: Winter meeting of the American Nuclear Society, Washington, DC (United States), 13-18 Nov 1994). Order Number DE95003690. Source: OSTI; NTIS; INIS; GPO Dep.

Offices under the Assistant Secretary for Environmental Restoration and Waste Management (EM) in the Department of Energy (DOE) and some National Laboratories are using Independent Technical or "Red Team" Reviews to understand and improve the performance of major projects, major system acquisitions, programs and organizations. A core group formed in 1991 by Los Alamos National Laboratory and Sandia National Laboratories, has organized teams of commercial and private consultants to perform over fifteen Independent Technical Reviews (ITRs) throughout the DOE Complex. This paper discusses: review initiation, team formation, methodology, site response, and observations gathered over the past three years.

5186 (LA-UR–94-3865) **Consequence assessment for the high-level waste tanks probabilistic risk assessment.** MacFarlane, D.R. (Los Alamos National Lab., NM (United States)); Kindinger, J.; Deremer, R.K. Los Alamos National Lab., NM (United States). [1995]. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9411156–1: International Atomic Energy Agency (IAEA) technical committee meeting, Vienna (Austria), 21-25 Nov 1994). Order Number DE95003698. Source: OSTI; NTIS; INIS; GPO Dep.

At the US DOE Hanford Site, there are 177 underground tanks in 18 separate tank farms containing accumulated liquid radioactive wastes from 50 yr of weapons materials production activities. The total volume is about 60 million gallons containing approximately 120 Curies of radioactivity. The radioactive material consists primarily of ^{137}Cs, ^{90}Sr, and transuranics. Risk concerns with the tanks are associated with possible energy releases because of the presence of flammable gases, organic liquids, reactive chemical compounds, and radioactive decay heat. Because of the high concentration of radioactivity in the wastes and because a large number of the older single-shell tanks have some history or evidence of leaking, there is a public perception that they pose a serious risk to the onsite workers and the offsite public. The tank farm probabilistic safety assessment (PSA) was performed for two reasons: (1) to develop a baseline estimate of the risks these wastes pose to the workers and the public for the present tank contents and configurations and (2) to provide a relative ranking of the risks associated with individual groups of tanks. The latter information would be helpful in planning the order of the tank remediation work by indicating which tanks pose the greatest risk; the former could help allay concerns.

5187 (LBL–35976) **Hydraulic conductivity of rock fractures.** Zimmerman, R.W.; Bodvarsson, G.S. Lawrence Berkeley Lab., CA (United States). Oct 1994. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95004815. Source: OSTI; NTIS; INIS; GPO Dep.

Yucca Mountain, Nevada contains numerous geological units that are highly fractured. A clear understanding of the hydraulic conductivity of fractures has been identified as an important scientific problem that must be addressed during the site characterization process. The problem of the flow of a single-phase fluid through a rough-walled rock fracture is discussed within the context of rigorous fluid mechanics. The derivation of the cubic law is given as the solution to the Navier-Stokes equations for flow between smooth, parallel plates, the only fracture geometry that is amenable to exact treatment. The various geometric and kinetic conditions that are necessary in order for the Navier-Stokes equations to be replaced by the more tractable lubrication or Hele-Shaw equations are studied and quantified. Various analytical and numerical results are reviewed pertaining to the problem of relating the effective hydraulic aperture to the statistics of the aperture distribution. These studies all lead to the conclusion that the effective hydraulic aperture is always less than the mean aperture, by a factor that depends on the ratio of the mean value of the aperture to its standard deviation. The tortuosity effect caused by regions where the rock walls are in contact with each other is studied using the Hele-Shaw equations, leading to a simple correction factor that depends on the area fraction occupied by the contact regions. Finally, the predicted hydraulic apertures are compared to measured values for eight data sets from the literature for which aperture and conductivity data were available on the same fracture. It is found that reasonably accurate predictions of hydraulic conductivity can be made based solely on the first two moments of the aperture distribution function, and the proportion of contact area. 68 refs.

5188 (NUREG/CR–4918-Vol.7) **Control of water infiltration into near surface LLW disposal units. Progress report on field experiments at a humid region site, Beltsville, Maryland: Volume 7.** Schulz, R.K. (California Univ., Los Angeles, CA (United States)); Ridky, R.W.; O'Donnell, E. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications; California Univ., Los Angeles, CA (United States); Maryland Univ., College Park, MD (United States). Dept. of Geology. Dec 1994. 22p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

The project objective is to assess means for controlling waste infiltration through waste disposal unit covers in humid regions. Experimental work is being performed in large scale lysimeters (70 ft x 45 ft x 10 ft) at Beltsville, MD and results of the assessment are applicable to disposal of LLW, uranium mill tailings, hazardous waste, and sanitary landfills. Three concepts are under investigation: (1) resistive layer barrier, (2) conductive layer barrier, and bioengineering water management. The resistive layer barrier consists of compacted earth (clay). The conductive layer barrier is a special case of the capillary barrier and it requires a flow layer (e.g. fine sandy loam) over a capillary break. As long as unsaturated conditions are maintained water is conducted by the flow layer to below the waste. This barrier is most efficient at low flow rates and is thus best placed below a resistive layer barrier. Such a combination of the resistive layer over the conductive layer barrier promises to be highly effective provided there is no appreciable subsidence. Bioengineering water management is a surface cover that is designed to accommodate subsidence. It consists of impermeable panels which enhance run-off and limit infiltration. Vegetation is planted in narrow openings between panels to transpire water from below the panels. This system has successfully dewatered two lysimeters thus demonstrating that this procedure could be used for remedial action (drying out) existing water-logged disposal sites at low cost.

5189 (NUREG/CR–6288) **Geochemical investigations related to the Yucca Mountain environment and potential nuclear waste repository.** Murphy, W.M. (Southwest Research Institute, San Antonio, TX (United States). Center for Nuclear Waste Regulatory Analyses); Pabalan, R.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications; Southwest Research Inst., San Antonio, TX (United States). Center for Nuclear Waste Regulatory Analyses. Nov 1994. 192p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This report presents final results of the Geochemistry Research Project conducted at the Center for Nuclear Waste Regulatory Analyses (CNWRA) for the Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research. The study focused on experimental determinations and theoretical interpretations of fundamental thermodynamic and kinetic properties of minerals and reactions that characterize geochemical processes at the proposed nuclear waste repository site at Yucca Mountain and that could affect the capacity of the site to isolate nuclear waste. Technical results are presented in three major sections covering (i) cation exchange studies on clinoptilolite, (ii) kinetic and solubility studies on analcime and Na-clinoptilolite, and (iii) conceptual and numerical geochemical modeling of natural and repository systems. Experimental studies were designed to advance knowledge of the fundamental properties of the zeolite minerals clinoptilolite and analcime through controlled tests at 25°C, and to interpret the data in the context of the geochemical system at Yucca Mountain. Cation exchange equilibria were determined for clinoptilotite and binary solutions of Na^+ with K^+, Ca^{2+}, and Sr^{2+} at several solution concentrations. Results were interpreted using a Margules solid solution model for clinoptilolite coupled with a Pitzer activity coefficient model for aqueous solutions. Experimental data for analcime and clinoptilolite dissolution rates were interpreted using postulated rate mechanisms, and corresponding rate constants were determined. Dissolution rate data for analcime can be rationalized by alternate mechanisms which invoke either the presence of ultrareactive material or rate dependence on aqueous aluminum. Reversed solubility determinations were interpreted to obtain equilibrium constants for dissolution reactions and standard state Gibbs free energies of formation of the minerals.

5190 (ORNL/ER–226) **Health and safety plan for the Environmental Restoration Program at Oak Ridge National Laboratory.** Clark, C. Jr.; Burman, S.N.; Cipriano, D.J. Jr.; Uziel, M.S.; Kleinhans, K.R.; Tiner, P.F. Oak Ridge National Lab., TN (United States). Aug 1994. 304p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003988. Source: OSTI; NTIS; INIS; GPO Dep.

This Programmatic Health and Safety plan (PHASP) is prepared for the U.S. Department of Energy (DOE) Oak Ridge National Laboratory (ORNL) Environmental Restoration (ER) Program. This plan follows the format recommended by the U.S. Environmental Protection Agency (EPA) for remedial investigations and feasibility studies and that recommended by the EM40 Health and Safety Plan (HASP) Guidelines (DOE February 1994). This plan complies with the Occupational Safety and Health Administration (OSHA) requirements found in 29 CFR 1910.120 and EM-40 guidelines for any activities dealing with hazardous waste operations and emergency response efforts and with OSHA requirements found in 29 CFR 1926.65. The policies and procedures in this plan apply to all Environmental Restoration sites and activities including employees of Energy Systems, subcontractors, and prime contractors performing work for the DOE ORNL ER Program. The provisions of this plan are to be carried out whenever activities are initiated that could be a threat to human health or the environment. This plan implements a policy and establishes criteria for the development of procedures for day-to-day operations to prevent or minimize any adverse impact to the environment and personnel safety and health and to meet standards that define acceptable management of hazardous and radioactive materials and wastes. The plan is written to utilize past experience and best management practices to minimize hazards to human health and safety and to the environment from event such as fires, explosions, falls, mechanical hazards, or any unplanned release of hazardous or radioactive materials to air, soil, or surface water.

5191 (ORNL/ER–275) **Surveillance and maintenance plan for the inactive liquid low-level waste tanks at Oak Ridge National Laboratory.** Oak Ridge National Lab., TN (United States). Nov 1994. 108p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003972. Source: OSTI; NTIS; INIS; GPO Dep.

ORNL has a total of 54 inactive liquid low-level waste (ILLLW) tanks. In the past, these tanks were used to contain radioactive liquid wastes from various research programs, decontamination operations, and reactor operations. The tanks have since been removed from service for various reasons; the majority were retired because of their age, some due to integrity compromises, and others because they did not meet the current standards set by the Federal Facilities Agreement (FFA). Many of the tanks contain residual radioactive liquids and/or sludges. Plans are to remediate all tanks; however, until remediation of each tank, this Surveillance and Maintenance (S&M) Plan will be used to monitor the safety and inventory containment of these tanks.

5192 (ORNL/TM–12786) **Laboratory development of methods for centralized treatment of liquid low-level waste at Oak Ridge National Laboratory.** Arnold, W.D.; Bostick, D.T.; Burgess, M.W.; Taylor, P.A.; Perona, J.J.; Kent, T.E. Oak Ridge National Lab., TN (United States). Oct 1994. 112p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95002441. Source: OSTI; NTIS; INIS; GPO Dep.

Improved centralized treatment methods are needed in the management of liquid low-level waste (LLLW) at Oak Ridge National Laboratory (ORNL). LLLW, which usually contains radioactive contaminants at concentrations up to millicurie-per-liter levels, has accumulated in underground storage tanks for over 10 years and has reached a volume of over 350,000 gal. These wastes have been collected since 1984 and are a complex mixture of wastes from past nuclear energy research activities. The waste is a highly alkaline 4-5 M $NaNO_3$ solution with smaller amounts of other salts. This type of waste will continue to be generated as a consequence of future ORNL research programs. Future LLLW (referred to as

newly generated LLLW or NGLLLW) is expected to a highly alkaline solution of sodium carbonate and sodium hydroxide with a smaller concentration of sodium nitrate. New treatment facilities are needed to improve the manner in which these wastes are managed. These facilities must be capable of separating and reducing the volume of radioactive contaminants to small stable waste forms. Treated liquids must meet criteria for either discharge to the environment or solidification for onsite disposal. Laboratory testing was performed using simulated waste solutions prepared using the available characterization information as a basis. Testing was conducted to evaluate various methods for selective removal of the major contaminants. The major contaminants requiring removal from Melton Valley Storage Tank liquids are ^{90}Sr and ^{137}Cs. Principal contaminants in NGLLLW are ^{90}Sr, ^{137}Cs, and ^{106}Ru. Strontium removal testing began with literature studies and scoping tests with several ion-exchange materials and sorbents.

5193 **Method to synthesize dense crystallized sodalite pellet for immobilizing halide salt radioactive waste.** Koyama, T. To Dept. of Energy. 1992. Filed date 11 Sep 1992. U.S. Patent Application 7-943,624. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95001782. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This report describes a method for immobilizing waste chloride salts containing radionuclides such as cesium and strontium and hazardous materials such as barium. A sodalite intermediate is prepared by mixing appropriate amounts of silica, alumina and sodium hydroxide with respect to sodalite and heating the mixture to form the sodalite intermediate and water. Heating is continued to drive off the water to form a water-free intermediate. The water-free intermediate is mixed with either waste salt or waste salt which has been contacted with zeolite to concentrate the radionuclides and hazardous material. The waste salt-intermediate mixture is then compacted and heated under conditions of heat and pressure to form sodalite with the waste salt, radionuclides and hazardous material trapped within the sodalite cage structure. This provides a final product having excellent leach resistant capabilities.

5194 (PNL–8901) **Development of a multi-functional scarifier dislodger with an integral pneumatic conveyance retrieval system for single-shell tank remediation. FY93 summary report.** Bamberger, J.A. (Pacific Northwest Lab., Richland, WA (United States)); McKinnon, M.A.; Alberts, D.A.; Steele, D.E.; Crowe, C.T. Pacific Northwest Lab., Richland, WA (United States). Oct 1994. 77p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004358. Source: OSTI; NTIS; INIS; GPO Dep.

The Underground Storage Tank Integrated Demonstration (UST-ID) is evaluating several hydraulic dislodger concepts and retrieval technologies to develop specifications for system that can retrieve wastes from single-shell tanks. Each of the dislodgers will be evaluated sequentially to determine its ability to fracture and dislodge various waste simulants such as salt cake, sludge, and viscous liquid. The retrieval methods will be evaluated to determine their ability to convey this dislodged material from the tank. This report describes on-going research that commenced in FY93 to develop specifications for a scarifier dislodger coupled with a pneumatic conveyance retrieval system. The scarifier development is described in Section 3; pneumatic conveyance development is described in Section 4. Preliminary system specifications are listed in Section 5. FY94 plans are summarized in Section 6.

5195 (PNL–10081) **Waste tank vapor project: Vapor characterization of Tank 241-C-103: Data report for OVS samples collected from Sample Job 7b, Parts I and II, received 5/18/94 and 5/24/94.** Clauss, T.R.; Edwards, J.A.; Fruchter, J.S. Pacific Northwest Lab., Richland, WA (United States). Sep 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004275. Source: OSTI; NTIS; INIS; GPO Dep.

On 5/18/94, Westinghouse Hanford Company (WHC) delivered samples to Pacific Northwest Laboratory (PNL) that were collected from waste Tank 241-C-103 on 5/16/94. These samples were from Sample Job (SJ) 7b, Part 1. On 5/24/94, WHC delivered samples to PNL that were collected from waste Tank 241-C-103 on 5/18/94. These samples were from SJ7b, Part 2. A summary of data derived from the sampling of waste Tank 241-C-103 for gravimetric (H_2O) and normal paraffin hydrocarbon (NPH) concentrations are shown for SJ7b. Gravimetric analysis was performed on the samples within 24 hours of receipt by PNL. The NPH concentration of 10 samples collected for Part 1 was slightly higher than the average concentration for 15 samples collected in Part 2, 812 ($\pm$ 133) mg/m^3 and 659 ($\pm$ 88) mg/m^3, respectively. The higher concentrations measured in Part 1 samples may be because the samples in Part 1 were collected at a single level, 0.79 meters above the air-liquid interface. Part 2 samples were collected at three different tank levels, 0.79, 2.92, and 5.05 m above the air-liquid interface. In Part 2, the average NPH concentrations for 5 samples collected at each of three levels was similar: 697 (60) mg/m^3 at the low level, 631 (51) mg/m^3 at the mid level, and 651 (134) mg/m^3 at the high level. It is important to note that the measured tridecane to dodecane concentration remained constant in all samples collected in Parts 1 and 2. That ratio is 1.2 $\pm$ 0.05. This consistent ratio indicates that there were no random analytical biases towards either compound.

5196 (PNL–10103) **Non-fuel assembly components: 10 CFR 61.55 classification for waste disposal.** Migliore, R.J.; Reid, B.D.; Fadeff, S.K.; Pauley, K.A.; Jenquin, U.P. Pacific Northwest Lab., Richland, WA (United States). Sep 1994. 150p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95000974. Source: OSTI; NTIS; INIS; GPO Dep.

This document reports the results of laboratory radionuclide measurements on a representative group of non-fuel assembly (NFA) components for the purposes of waste classification. This document also provides a methodology to estimate the radionuclide inventory of NFA components, including those located outside the fueled region of a nuclear reactor. These radionuclide estimates can then be used to determine the waste classification of NFA components for which there are no physical measurements. Previously, few radionuclide inventory measurements had been performed on NFA components. For this project, recommended scaling factors were selected for the ORIGEN2 computer code that result in conservative estimates of radionuclide concentrations in NFA components. These scaling factors were based upon experimental data obtained from the following NFA components: (1) a pressurized water reactor (PWR) burnable poison rod assembly, (2) a PVM rod cluster control assembly, and (3) a boiling water reactor cruciform control rod blade. As a whole, these components were found to be within Class C limits. Laboratory radionuclide measurements for these components are provided in detail.

5197 (PNL–10160) **Cesium uptake capacity of simulated ferrocyanide tank waste. Interim report FY 1994, Ferrocyanide Safety Project.** Burgeson, I.E.; Bryan, S.A.; Burger, L.E. Pacific Northwest Lab., Richland, WA (United States). Sep 1994. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95002855. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this project is to determine the capacity for ^{137}CS uptake by mixed metal ferrocyanides present in Hanford waste tanks, and to assess the potential for aggregation of these ^{137}CS exchanged materials to form tank "hot-spots." This research, performed at the Pacific Northwest Laboratory (PNL) for the Westinghouse Hanford Company (WHC), stems from concerns of possible localized radiolytic heating within the tanks. If radioactive cesium is exchanged and concentrated by the remaining nickel ferrocyanide present in the tanks, this heating could cause temperatures to rise above the safety limits specified for the ferrocyanide tanks. For the purposes of this study, two simulants, In-Farm-2 and U-Plant-2, were chosen to represent the wastes generated by the scavenging processes. These simulants were formulated using protocols from the original cesium scavenging campaign. Later additions of cesium-rich wastes from various processes also were considered. The simulants were prepared and centrifuged to obtain a moist ferrocyanide sludge. The centrifuged sludges were treated with the original supernate spiked with a known amount of cesium nitrate. After analysis by flame atomic absorption spectrometry, distribution coefficients (K_d) were calculated. The capacity of solid waste simulants to exchange radioactive cesium from solution was

examined. Initial results showed that the greater the molar ratio of cesium to cesium nickel ferrocyanide, the less effective the exchange of cesium from solution. The theoretical capacity of 2 mol cesium per mol of nickel ferrocyanide was not observed. The maximum capacity under experimental conditions was 0.35 mol cesium per mol nickel ferrocyanide. Future work on this project will examine the layering tendency of the cesium nickel ferrocyanide species.

5198 (PNL–10161) **Organic Tanks Safety Program: Waste aging studies.** Camaioni, D.M.; Samuels, W.D.; Lenihan, B.D.; Clauss, S.A.; Wahl, K.L.; Campbell, J.A. Pacific Northwest Lab., Richland, WA (United States). Nov 1994. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004359. Source: OSTI; NTIS; INIS; GPO Dep.

The underground storage tanks at the Hanford Complex contain wastes generated from many years of plutonium production and recovery processes, and mixed wastes from radiological degradation processes. The chemical changes of the organic materials used in the extraction processes have a direct on several specific safety issues, including potential energy releases from these tanks. This report details the first year's findings of a study charged with determining how thermal and radiological processes may change the composition of organic compounds disposed to the tank. Their approach relies on literature precedent, experiments with simulated waste, and studies of model reactions. During the past year, efforts have focused on the global reaction kinetics of a simulated waste exposed to γ radiation, the reactions of organic radicals with nitrite ion, and the decomposition reactions of nitro compounds. In experiments with an organic tank non-radioactive simulant, the authors found that gas production is predominantly radiolytically induced. Concurrent with gas generation they observe the disappearance of EDTA, TBP, DBP and hexone. In the absence of radiolysis, the TBP readily saponifies in the basic medium, but decomposition of the other compounds required radiolysis. Key organic intermediates in the model are C-N bonded compounds such as oximes. As discussed in the report, oximes and nitro compounds decompose in strong base to yield aldehydes, ketones and carboxylic acids (from nitriles). Certain aldehydes can react in the absence of radiolysis to form H_2. Thus, if the pathways are correct, then organic compounds reacting via these pathways are oxidizing to lower energy content. 75 refs.

5199 (PNL–10163) **Computational analysis of coupled fluid, heat, and mass transport in ferrocyanide single-shell tanks: FY 1994 interim report. Ferrocyanide Tank Safety Project.** McGrail, B.P. Pacific Northwest Lab., Richland, WA (United States). Nov 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004226. Source: OSTI; NTIS; INIS; GPO Dep.

A computer modeling study was conducted to determine whether natural convection processes in single-shell tanks containing ferrocyanide wastes could generate localized precipitation zones that significantly concentrate the major heat-generating radionuclide, ^{137}Cs. A computer code was developed that simulates coupled fluid, heat, and single-species mass transport on a regular, orthogonal finite-difference grid. The analysis showed that development of a "hot spot" is critically dependent on the temperature dependence for the solubility of $Cs_2NiFe(CN)_6$ or $CsNaNiFe(CN)_6$. For the normal case, where solubility increases with increasing temperature, the net effect of fluid flow, heat, and mass transport is to disperse any local zones of high heat generation rate. As a result, hot spots cannot physically develop for this case. However, assuming a retrograde solubility dependence, the simulations indicate the formation of localized deposition zones that concentrate the ^{137}Cs near the bottom center of the tank where the temperatures are highest. Recent experimental studies suggest that $Cs_2NiFe(CN)_6(c)$ does not exhibit retrograde solubility over the temperature range 25°C to 90°C and NaOH concentrations to 5 M. Assuming these preliminary results are confirmed, no natural mass transport process exists for generating a hot spot in the ferrocyanide single-shell tanks.

5200 (PNL–10170) **Acquisition and reduction of data obtained from Tank 101-SY in-situ ball rheometer.** Shepard, C.L. (and others); Chieda, M.A.; Kirihara, L.J. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004986. Source: OSTI; NTIS; INIS; GPO Dep.

Development of the ball rheometer to measure rheological properties and density of the waste in Hanford Tank 241-SY-101 will be completed around September 1994. Since the ball rheometer project began, a mixer pump has been installed in this tank, and by all accounts this pump has been very successful at mitigating the flammable gas problem associated with Tank 101-SY. Present plans now call for the use of mixer pumps in several other tanks. The ball rheometer will serve as a diagnostic tool for judging the effectiveness of mixing in Tank 101-SY and others and will be one of few in-situ probes available for diagnostic measurements. The in-situ data collection strategy and the methods of data analysis and reduction are presented in this final report concerning this instrument. It is believed that a generalized Bingham fluid model (Herschel-Bulkley fluid model) may be useful for describing at least some of the waste contained in Tank 101-SY, and data obtained in the tank will initially be reduced using this fluid model. The single largest uncertainty in the determination of the drag force on the ball is the drag force which will be experienced by the cable attached to the ball. This drag can be a substantial fraction of the total drag when the ball is deep within the tank. Careful accounting of the cable drag will be important in the reduction of the data. The data collection strategy allows the determination of the waste fluid rheology both in the undisturbed state and after it has been disturbed by the ball. Fluid density will be measured at regular intervals.

5201 (PNL–10171) **Report on data requirements and hardware selection for in-situ ball viscometer.** Shepard, C.L. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004276. Source: OSTI; NTIS; INIS; GPO Dep.

The in-situ ball rheometer is designed to provide data concerning the rheological properties of the waste contained in tank 101-SY. It is imperative that the data collected and the results obtained are useful to the community presently concerned with the mitigation of the waste contained within this tank. To ensure that this objective is met, discussions were held with representatives of different groups in order to determine their data needs. This report is a synopsis of these discussions. Four separate groups were identified as potential users of the data. Persons contacted included Don Trent (Pacific Northwest Laboratory (PNL)), who is involved with Tempest modeling of the tank; Randy Marlow and John Strehlow (Westinghouse Hanford Company (WHC)), involved with structural analysis of the tank; Kemal Pasamehmetoglu and Cetin Unal (Los Alamos National Laboratory (LANL)), who are concerned with the safety analysis of activities performed within the tank; and Judith Bamberger, Paul Scott, and Gita Golcar (PNL) who are involved with the eventual retrieval of waste from the tank. Very specific questions were asked of these groups, including: From where in the tank are data needed? When should data be collected? In what manner are the data useful? What is the required accuracy of the data? Responses from each group are given.

5202 (PNL–10209) **Waste Tank Vapor Project: Enhancements to the PNL SUMMA™ analytical laboratory tank organic vapor support task.** McVeety, B.D.; Lucke, R.B.; Clauss, T.R.; Fruchter, J.S.; Goheen, S.C. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004277. Source: OSTI; NTIS; INIS; GPO Dep.

This report provides the status, as of the end of FY 1994, on the individual components of the SUMMA™ Canister Analytical Laboratory that Pacific Northwest Laboratory has assembled to support the Hanford Tank Safety Issues Program.

5203 (PNL–10240) **Theory of operation for the ball rheometer.** Shepard, C.L. (Pacific Northwest Lab., Richland, WA (United States)); Colson, J.B.; Pasamehmetoglu, K.O.; Unal, C.; Edwards, J.N.; Abbott, J. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004278. Source: OSTI; NTIS; INIS; GPO Dep.

The Hanford Site contains over 100 high-volume tanks containing high-level radioactive wastes. The tank which has received the most attention is Tank 101-SY, which is a double shell tank containing a caustic mixed-waste slurry. The ball rheometer developed in this work is intended at least initially for application in this tank. Tank 101-SY is known to periodically release flammable and toxic gases during events known as rollovers. The tank waste is largely made up of two layers, a supernatant liquid layer underneath which is a thick sludge layer. The two layers are called the convective (C) and the nonconvective (NC) regions, so called because of the thermal transport properties ascribed to each. Although they have significant uncertainty, the current theology data suggest the existence of a yield stress in the highly viscous nonconvective layer. Gas generated in the waste can be held in the NC layer if the material yield strength or its viscosity is high enough. Gas cannot be held in the C layer to any appreciable extent unless it is in solution. As gas continues to be generated by chemical or other processes, the number of gas bubbles and/or their sizes increases in the NC layer. A rollover occurs when the amount of gas trapped in the nonconvective region becomes great enough to overcome forces holding it in place. These forces are believed to be dependent on the theology of the nonconvective region and perhaps the bubble surface tension. The buoyancy forces on the bubbles exceed the restraining forces arising from the yield stress and the viscosity of the NC layer. Theology is then seen to be quite important in determining the nature of gas release events in this tank.

5204 (PNL–10275) **Hanford protoype surface barrier status report: FY 1994.** Gee, G.W.; Freeman, H.D.; Walters, W.H. Jr.; Ligotke, M.W.; Campbell, M.D.; Ward, A.L.; Link, S.O.; Smith, S.K.; Gilmore, B.G.; Romine, R.A. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004714. Source: OSTI; NTIS; INIS; GPO Dep.

A full-scale prototype surface barrier has been constructed at the 200 BP-1 Operable Unit in the 200 East Area of the Hanford Site. The prototype barrier has been built to evaluate design, construction, and performance features of a surface barrier that may be used for in-place disposal of wastes at the Hanford Site. The design basis and construction of the prototype have been documented. A testing and monitoring plan has been published outlining specific tests planned for the prototype. The current report describes initial testing activities conducted in FY 1994 and outlines activities for testing and monitoring at the prototype barrier in the future. Asphalt permeability was tested during construction of the prototype in April and May 1994. Cores taken from the asphalt concrete layer were tested in the laboratory and found to have hydraulic conductivities below 1E-09 cm/s. Field measurements of hydraulic conductivity taken on the asphalt concrete using a specially-designed falling head permeameter were more than ten times higher than those from core tests. The higher values are attributed to transient flow through the permeameter seal. In spite of this difficulty, the more rapid field measurements (1-day tests in the field compared to 3 months in the laboratory) gave values as low as IE-09 cm/s and averaged about IE-08 cm/s. Samples of fluid-applied asphalt material, used as a sealant on the asphalt concrete layer, were. tested in the laboratory and found to have hydraulic conductivities below IE-10 cm/s. Measurements of hydraulic conductivity taken on an adjacent asphalt test pad using a sealed double-ring infiltrometer (SDRI) were initiated in September 1994 and are expected to be completed in November 1994. Construction of the prototype surface barrier was completed in August 1994.

5205 (PNRI-E(NM)–94003) **Management of liquid radioactive wastes at PNRI.** Garcia, C.M. Philippine Nuclear Research Inst., Diliman, Quezon City (Philippines). Nuclear Regulations, Licensing and Safeguards Div. Oct 1994. 35p. Order Number DE95611247. Source: OSTI; NTIS (US Sales Only); INIS.

Liquid wastes accepted at PNRI waste management facility are generated by hospitals and research institutions from all over the country including those generated from the research laboratories within the PNRI. The operation of the Philippine TRIGA Research Reactor is also a potential source of liquid waste to be handled and managed by the facility in the future. This technical report is a result of the study of the present status and development of the management of liquid wastes at PNRI. (auth.). 8 refs.; 3 figs.; 4 tabs.

5206 (PNRI-E(NM)–94004) **Analytical methods of radwaste characterization.** Garcia, C.M. Philippine Nuclear Research Inst., Diliman, Quezon City (Philippines). Nuclear Regulations, Licensing and Safeguards Div. Oct 1994. 15p. Order Number DE95611248. Source: OSTI; NTIS (US Sales Only); INIS.

In view of the need to carry out more extensive studies on the design of newly proposed methods for the treatment of radioactive wastes collected at PNRI, this study is aimed to provide a guide in the characterization of wastes which is a preparatory step for a well-planned waste processing. (auth.). 8 refs.

5207 (RFP–4641) **An investigation of gas separation membranes for reduction of thermal treatment emissions.** Stull, D.M. (EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant); Logsdon, B.W.; Pellegrino, J.J. EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant. 16 May 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC34-90RF62349. Order Number DE94016221. Source: OSTI; NTIS; INIS; GPO Dep.

Gas permeable membranes were evaluated for possible use as air pollution control devices on a fluidized bed catalytic incineration unit. The unit is a candidate technology for treatment of certain mixed hazardous and radioactive wastes at the Rocky Flats Plant. Cellulose acetate and polyimide membranes were tested to determine the permeance of typical off-gas components such as carbon dioxide, nitrogen, and oxygen. Multi-component permeation studies included gas mixtures containing light hydrocarbons. Experiments were also conducted to discover information about potential membrane degradation in the presence of organic compounds.

5208 (SAND–92-2470) **Intermediate scale borehole (Room C): In situ data report (January 1989–June 1993).** Munson, D.E. (Sandia National Labs., Albuquerque, NM (United States). Repository Isolation Systems Dept.); Christian-Frear, T.L.; Baird, G.T.; Labreche, D.A.; Ball, J.R.; Jones, R.L.; Northrop-Salazar, C.L. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 194p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004989. Source: OSTI; NTIS; INIS; GPO Dep.

Data are presented from the intermediate scale borehole test, an in situ test fielded in the pillar separating Rooms C1 and C2 at the Waste Isolation Pilot Plant (WIPP). The test was to provide data on the influence of scale, if any, on the structural behavior of underground openings in salt. These data include selected fielding information, test configuration, instrumentation activities, and comprehensive results from a large number of gages. Construction of the test began in December 1989, with the drilling of the intermediate scale borehole in December 1990. Gage data in this report cover the period from January 1989 through June 1993.

5209 (SAND–93-7106C) **Mountain scale modeling of transient, coupled gas flow, heat transfer and carbon-14 migration.** Lu, Ning (Disposal Safety, Inc., Washington, DC (United States)); Ross, B. Sandia National Labs., Albuquerque, NM (United States). [1993]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9309228–13: Focus 93: site characterization and model validation, Las Vegas, NV (United States), 26-29 Sep 1993). Order Number DE95003351. Source: OSTI; NTIS; INIS; GPO Dep.

We simulate mountain-scale coupled heat transfer and gas flow at Yucca Mountain. A coupled rock-gas flow and heat transfer model, TGIF2, is used to simulate mountain-scale two-dimensional transient heat transfer and gas flow. The model is first verified against an analytical solution for the problem of an infinite horizontal layer of fluid heated from below. Our numerical results match very well with the analytical solution. Then, we obtain transient temperature and gas flow distributions inside the mountain. These distributions are used by a transient semianalytical particle tracker to obtain carbon-14 travel times for particles starting at different locations within the repository. Assuming that the repository is filled with 30-year-old waste at an initial areal power density of 57 kw/acre, we find that repository temperatures remain above 60°C for more than 10,000 years. Carbon-14 travel times to the surface are

mostly less than 1000 years, for particles starting at any time within the first 10,000 years.

5210 (SAND–93-7109) **Development of models for fast fluid pathways through unsaturated heterogeneous porous media.** Robey, T.H. (Spectra Research Inst., Albuquerque, NM (United States)). Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 112p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004269. Source: OSTI; NTIS; INIS; GPO Dep.

The pre-waste-emplacement ground water travel time requirement is a regulatory criterion that specifies ground water travel time to the accessible environment shall be greater than 1,000 years. Satisfying the ground water travel time criterion for the potential repository at Yucca Mountain requires the study of fast travel path formation in the unsaturated zone and development of models that simulate the formation of fast paths. Conceptual models for unsaturated flow that have been used for total-systems performance assessment generally fall into the categories of composite-porosity or fracture models. The actual hydrologic conditions at Yucca Mountain are thought to lie somewhere between the extremes of these two types of models. The current study considers the effects of heterogeneities on composite-porosity models and seeks to develop numerical methods (and models) that can produce locally saturated zones where fracture flow can occur. The credibility of the model and numerical methods is investigated by using test data from the INTRAVAL project (Swedish Nuclear Inspectorate, 1992) to attempt to predict in-situ volumetric water content at specific locations in Yucca Mountain. Work based on the numerical methods presented in this study is eventually intended to allow the calculation of ground water travel times in heterogeneous media. 60 refs.

5211 (SAND–94-0482) **Scenario development for the Waste Isolation Pilot Plant: Building confidence in the assessment.** Galson, D.A.; Swift, P.N. Sandia National Labs., Albuquerque, NM (United States). Jul 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE94017291. Source: OSTI; NTIS; INIS; GPO Dep.

Scenario development is part of the iterative performance assessment (PA) process for the Waste Isolation Pilot Plant (WIPP). Scenario development for the WIPP has been the subject of intense external review and is certain to be the subject of continued scrutiny as the project proceeds toward regulatory compliance. The principal means of increasing confidence in this aspect of the PA will be through the use of the systematic and thorough procedure toward developing the scenarios and conceptual models on which the assessment is to be based. Early and ongoing interaction with project reviewers can assist with confidence building. Quality of argument and clarity of presentation in PA will be of key concern. Appropriate tools are required for documenting and tracking assumptions, through a single assessment phase, and between iterative assessment phases. Risks associated with future human actions are of particular concern to the WIPP project, and international consensus on the principles for incorporation of future human actions in assessments would be valuable.

5212 (SAND–94-2243C) **Mechanical and bulk properties of intact rock collected in the laboratory in support of the Yucca Mountain Site Characterization Project.** Price, R.H. (Sandia National Labs., Albuquerque, NM (United States)); Martin, R.J. III; Boyd, P.J.; Boinott, G.N. Sandia National Labs., Albuquerque, NM (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9409238–1: Workshop on rock mechanics, Rockville, MD (United States), 19-20 Sep 1994). Order Number DE95001883. Source: OSTI; NTIS; INIS; GPO Dep.

A comprehensive laboratory investigation is determining the mechanical properties of tuffs for the Yucca Mountain Site Characterization Project (YMP). Most recently, experiments have been performed on tuff samples from a series of drill holes along the planned alignment of the Exploratory Study Facilities (ESF) north ramp. Unconfined compression and indirect tension experiments were performed and the results are being analyzed with the help of bulk property information. The results on samples from eight of the drill holes are presented. In general, the properties vary widely, but are highly dependent on the sample porosity. The developed relationships between mechanical properties and porosity are powerful tools in the effort to model the rock mass response of Yucca Mountain to the emplacement of the potential high-level radioactive waste repository.

5213 (SD-WM-TI–230-Rev.2) **As-built design criteria: B-234 cathodic protection, C.P. wire to pipe connections.** Brezler, T.A. Westinghouse Hanford Co., Richland, WA (United States). 14 Nov 1994. 148p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003762. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the as-built conditions (cathodic protection wire connections to miscellaneous underground piping) that do not otherwise exist on the current "Released for Construction" design drawings. A note will be added to each applicable drawing, referencing this support document.

5214 (UCRL-ID–119129) **Molten salt destruction of rubber and chlorinated solvents.** Upadhye, R.S.; Wilder, J.G. Lawrence Livermore National Lab., CA (United States). Sep 1994. 95p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95004824. Source: OSTI; NTIS; INIS; GPO Dep.

Acceptable methods for the treatment of mixed wastes are not currently available. The authors have investigated Molten Salt Destruction (MSD) as an alternative to incineration of mixed wastes. MSD differs from incineration in several ways: there is no evidence of open flames in MSD, the containment of actinides is accomplished by chemical means (wetting and dissolution), the operating temperature of MSD is much lower (700–590 C vs 1,000–1,200 C) thus lowering the volatility of actinides. Furthermore, no acid gases are released from MSD. These advantages provide the main incentive for developing MSD as an alternative to incineration. The authors have demonstrated the viability of the MSD process to cleanly destroy rubber and chlorinated solvents.

5215 (UCRL-JC–116435) **Stochastic modeling of the influence of environment on pitting corrosion damage of radioactive-waste containers.** Henshall, G.A. Lawrence Livermore National Lab., CA (United States). Jun 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941075–5: 18. international symposium on the scientific basis for nuclear waste management, Kyoto (Japan), 23-27 Oct 1994). Order Number DE95002395. Source: OSTI; NTIS; INIS; GPO Dep.

A physically-based, phenomenological stochastic model for pit initiation and growth is presented as a potential tool for predicting the degradation of high-level radioactive-waste containers by aqueous pitting corrosion. Included in the model are simple phenomenological equations describing the dependence of the controlling stochastic parameters on the applied (or corrosion) potential, chloride ion concentration, and absolute temperature. Results from this model are presented that demonstrate its ability to simulate several important environmental effects on pitting.

5216 (UCRL-JC–117575) **Molten salt destruction as an alternative to open burning of energetic material wastes.** Upadhye, R.S.; Watkins, B.E.; Pruneda, C.O.; Brummond, W.A. Lawrence Livermore National Lab., CA (United States). 5 Jul 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9409178–2: American Chemical Society meeting on industrial and engineering chemistry, Atlanta, GA (United States), 19-21 Sep 1994). Order Number DE94016171. Source: OSTI; NTIS; INIS; GPO Dep.

LLNL has built a small-scale (about 1 kg/hr throughput unit to test the destruction of energetic materials using the Molten Salt Destruction (MSD) process. We have modified the unit described in the earlier references to inject energetic waste material continuously into the unit. In addition to the HMX, other explosives we have destroyed include RDX, PETN, ammonium picrate, TNT, nitroguanadine, and TATB. We have also destroyed a liquid gun propellant comprising hydroxyl ammonium nitrate, triethanolammonium nitrate and water. In addition to these pure components, we have destroyed a number of commonly used formulations, such as LX-10 (HMX/Viton), LX-16 (PETN/FPC461, LX-17 (TATB/Kel F),

and PBX-9404 (HMX)/CEF/Nitro cellulose). Our experiments have demonstrated that energetic materials can be safely and effectively treated by MSD.We have also investigated the issue of steam explosions in molten salt units, both experimentally and theoretically, and concluded that steam explosions can be avoided under proper design and operating conditions. We are currently building a larger unit (nominal capacity 5 kg/hr,) to investigate the relationship between residence time, temperature, feed concentration and throughputs, avoidance of back-burn, a;nd determination of the products of combustion under different operating conditions.

5217 (USGS-OFR–92-458) **Evidence of prehistoric flooding and the potential for future extreme flooding at Coyote Wash, Yucca Mountain, Nye County, Nevada.** Glancy, P.A. US-DOE Nevada Operations Office, Las Vegas, NV (United States). 1994. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. Order Number DE94018347. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

Coyote Wash, an approximately 0.3-square-mile drainage on the eastern flank of Yucca Mountain, is the potential location for an exploratory shaft to evaluate the suitability of Yucca Mountain for construction of an underground repository for the storage of high-level radioactive wastes. An ongoing investigation is addressing the potential for hazards to the site and surrounding areas from flooding and related fluvial-debris movement. Unconsolidated sediments in and adjacent to the channel of North Fork Coyote Wash were examined for evidence of past floods. Trenches excavated across and along the valley bottom exposed multiple flood deposits, including debris-flow deposits containing boulders as large as 2 to 3 feet in diameter. Most of the alluvial deposition probably occurred during the late Quaternary. Deposits at the base of the deepest trench overlie bedrock and underlie stream terraces adjacent to the channel; these sediments are moderately indurated and probably were deposited during the late Pleistocene. Overlying nonindurated deposits clearly are younger and may be of Holocene age. This evidence of intense flooding during the past indicates that severe flooding and debris movement are possible in the future. Empirical estimates of large floods of the past range from 900 to 2,600 cubic feet per second from the 0.094-square-mile drainage area of North Fork Coyote Wash drainage at two proposed shaft sites. Current knowledge indicates that mixtures of water and debris are likely to flow from North Fork Coyote Wash at rates up to 2,500 cubic feet per second. South Fork Coyote Wash, which has similar basin area and hydraulic characteristics, probably will have concurrent floods of similar magnitudes. The peak flow of the two tributaries probably would combine near the potential sites for the exploratory shaft to produce future flow of water and accompanying debris potentially as large as 5,000 cubic feet per second.

5218 (USGS-OFR–93-540-A) **Gravity and magnetic data of Midway Valley, southwest Nevada.** Ponce, D.A. (Geological Survey, Menlo Park, CA (United States)); Langenheim, V.E.; Sikora, R.F. Geological Survey, Denver, CO (United States). 1993. 22p. Sponsored by USDOE, Washington, DC (United States);Department of the Interior, Washington, DC (United States). DOE Contract AI08-92NV10874. Order Number DE95004229. Source: OSTI; NTIS; INIS; US Geological Survey, Open-File Reports - ESIC, Box 25425, Federal Center, Denver, CO 80225; GPO Dep.

Detailed gravity and ground magnetic data collected along five traverses across Midway Valley on the eastern flank of Yucca Mountain in southwest Nevada are described. These data were collected as part of an effort to evaluate faulting in the vicinity of proposed surface facilities for a potential nuclear waste repository at Yucca Mountain. Geophysical data show that Midway Valley is bounded by large gravity and magnetic anomalies associated with the Bow Ridge and Paintbrush Canyon faults, on the west side of Exile Hill and on the west flank of Fran Ridge, respectively. In addition, Midway Valley itself is characterized by a number of small-amplitude anomalies that probably reflect small-scale faulting beneath Midway Valley.

5219 (USGS-OFR–93-586-A) **Gravity and magnetic study of Yucca Wash, southwest Nevada.** Langenheim, V.E. (Geological Survey, Menlo Park, CA (United States)); Ponce, D.A.; Oliver, H.W.; Sikora, R.F. Geological Survey, Denver, CO (United States). 1993. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. Order Number DE95004228. Source: OSTI; NTIS; INIS; US Geological Survey, Open-File Reports - ESIC, Box 25425, Federal Center, Denver, CO 80225; GPO Dep.

Gravity and ground magnetic data were collected along five traverses across and one traverse along Yucca Wash in the southwest quadrant of the Nevada Test Site. Two additional ground magnetic profiles were collected approximately 100 m to either side of the longitudinal profile. These data do not indicate major vertical offsets greater than 100 m using a density contrast of 0.2 to 0.3 g/cm^3 along the proposed Yucca Wash fault. A broad magnetic high coincides with the location of the hydrologic gradient. Density profiling, a technique used to determine the average density of small topographic features, suggests that the density of near-surface material in the vicinity of Yucca Wash is about 2.0 g/cm^3.

5220 (USGS/WRI–92-4016) **Preliminary hydrogeologic assessment of boreholes UE-25c No. 1, UE-25c No. 2, and UE-25c No. 3, Yucca Mountain, Nye County, Nevada.** Geldon, A.L. Geological Survey, Denver, CO (United States). 1993. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-92NV10874. Order Number DE95003785. Source: OSTI; NTIS; INIS; U.S. Geological Survey, Earth Science Information Center, Open File Reports Section, Box 25286, MS 517, Federal Center, Denver, CO 80225; GPO Dep.

The purpose of this report is to characterize-the hydrogeology of saturated tuffaceous rocks penetrated by boreholes UE-25c #1, UE-25c #2, and UE-25c #3. These boreholes are referred to collectively in this report as the C-holes. The C-holes were drilled to perform multiwell aquifer tests and tracer tests; they comprise the only complex of closely spaced boreholes completed in the saturated zone at Yucca Mountain. Results of lithologic and geophysical logging, fracture analyses, water-level monitoring, temperature and tracejector surveys aquifer tests, and hydrochemical sampling completed at the C-hole complex as of 1986 are assessed with respect to the regional geologic and hydrologic setting. A conceptual hydrogeological model of the Yucca Mountain area is presented to provide a context for quantitatively evaluating hydrologic tests performed at the C-hole complex as of 1985, for planning and interpreting additional hydrologic tests at the C-hole complex, and for possibly re-evaluating hydrologic tests in boreholes other than the C-holes.

5221 (WHC-EP–0496-Rev.1) **Westinghouse Hanford Company Pollution Prevention Program Implementation Plan.** Floyd, B.C. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003268. Source: OSTI; NTIS; INIS; GPO Dep.

This plan documents Westinghouse Hanford Company's (WHC) Pollution Prevention (P2) (formerly Waste Minimization) program. The program includes WHC; BCS Richland, Inc. (BCSR); and ICF Kaiser Hanford Company (ICF KH). The plan specifies P2 program activities and schedules for implementing the Hanford Site Waste Minimization and Pollution Prevention Awareness (WMin/P2) Program Plan requirements (DOE 1994a). It is intended to satisfy the U.S. Department of Energy (DOE) and other legal requirements that are discussed in both the Hanford Site WMin/P2 plan and paragraph C of this plan. As such, the Pollution Prevention Awareness Program required by DOE Order 5400.1 (DOE 1988) is included in the WHC P2 program. WHC, BCSR, and ICF KH are committed to implementing an effective P2 program as identified in the Hanford Site WMin/P2 Plan. This plan provides specific information on how the WHC P2 program will develop and implement the goals, activities, and budget needed to accomplish this. The emphasis has been to provide detailed planning of the WHC P2 program activities over the next 3 years. The plan will guide the development and implementation of the program. The plan also provides background information on past program activities. Because the plan contains greater detail than in the past, activity scope and implementation schedules may change as new priorities are identified and new approaches are developed and realized. Some activities will be accelerated, others may be delayed; however, all of the

general program elements identified in this plan and contractor requirements identified in the Site WMin/P2 plan will be developed and implemented during the next 3 years. This plan applies to all WHC, BCSR, and ICF KH organizations and subcontractors. It will be distributed to those with defined responsibilities in this plan; and the policy, goals, objectives, and strategy of the program will be communicated to all WHC, BCSR, and ICF KH employees.

5222 (WHC-EP–0739) **Tank characterization report for Single-Shell Tank 241-BX-107.** Raphael, G.F. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 238p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004102. Source: OSTI; NTIS; INIS; GPO Dep.

This study examined and assessed the status, safety issues, composition, and distribution of the wastes contained in the tank 241-BX-107. Historical and most recent information, ranging from engineering structural assessment experiments, process history, monitoring and remediation activities, to analytical core sample data, were compiled and interpreted in an effort to develop a realistic, contemporary profile for the tank BX-107 contents. The results of this is study revealed that tank BX-107, a 2,006,050 L (530,000 gal) cylindrical single-shell, dished-bottom carbon-steel tank in the 200 East Area of the Hanford Site, was classified as sound. It has been interim stabilized and thus contains less than 189,250 L (50,000 gal) of interstitial liquid, and less than 18,925 L (5,000 gal) of supernatant. It has also been partially interim isolated, whereby all inlets to the tank are sealed to prevent inadvertent addition of liquid. At a residual waste level of ~3.07 m (120.7 ± 2 in. from sidewall bottom or ~132.9 in. from center bottom), it is estimated that the tank BX-107 contents are equivalent to 1,305,825 L (345,000 gal). The vapor space pressure is at atmospheric. The latest temperature readings, which were taken in July 1994, show a moderate temperature value of 19°C (66°F). Two supernatant samples were collected in 1974 and 1990, prior to interim stabilization. Sludge core samples were obtained in 1979 and 1992.

5223 (WHC-SA–1601) **Description of the grout system dynamic simulation.** Zimmerman, B.D. Westinghouse Hanford Co., Richland, WA (United States). Jul 1993. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-921102–64: Joint American Nuclear Society/European Nuclear Society (ANS/ENS) international meeting on fifty years of controlled nuclear chain reaction: past, present, and future, Chicago, IL (United States), 15-20 Nov 1992). Order Number DE95004104. Source: OSTI; NTIS; INIS; GPO Dep.

The grout system dynamic computer simulation was created to allow investigation of the ability of the grouting system to meet established milestones, for various assumed system configurations and parameters. The simulation simulates the movement of tank waste through the system versus time, from initial storage tanks, through feed tanks and the grout plant, then finally to a grout vault. The simulation properly accounts for the following (1) time required to perform various actions or processes, (2) delays involved in gaining regulatory approval, (3) random system component failures, (4) limitations on equipment capacities, (5) available parallel components, and (6) different possible strategies for vault filling. The user is allowed to set a variety of system parameters for each simulation run. Currently, the output of a run primarily consists of a plot of projected grouting campaigns completed versus time, for comparison with milestones. Other outputs involving any model component can also be quickly created or deleted as desired. In particular, sensitivity runs where the effect of varying a model parameter (flow rates, delay times, number of feed tanks available, etc.) on the ability of the system to meet milestones can be made easily. The grout system simulation was implemented using the ITHINK* simulation language for Macintosh** computers.

5224 (WHC-SA–2447) **Identification of single-shell tank in-tank hardware obstructions to retrieval at Hanford Site Tank Farms.** Ballou, R.A. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950232–11: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95003044. Source: OSTI; NTIS; INIS; GPO Dep.

Two retrieval technologies, one of which uses robot-deployed end effectors, will be demonstrated on the first single-shell tank (SST) waste to be retrieved at the Hanford Site. A significant impediment to the success of this technology in completing the Hanford retrieval mission is the presence of unique tank contents called in-tank hardware (ITH). In-tank hardware includes installed and discarded equipment and various other materials introduced into the tank. This paper identifies those items of ITH that will most influence retrieval operations in the arm-based demonstration project and in follow-on tank operations within the SST farms.

5225 (WHC-SA–2448) **First generation long-reach manipulator for retrieval of waste from Hanford single-shell tanks.** Gibbons, P.W.; McDaniel, L.B. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950232–12: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95003045. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy, Richland Operations Office, has established the Tank Waste Remediation System to resolve environmental and safety issues related to underground waste-storage tanks at the Hanford Site. The Tank Waste Remediation System has identified the use of an advanced-technology, long-reach manipulator system as a low-water-addition retrieval alternative to past-practice sluicing.

5226 (WHC-SA–2539) **Recommendations for erosion-corrosion allowance for Multi-Function Waste Tank Facility tanks.** Carlos, W.C. (Westinghouse Hanford Co., Richland, WA (United States)); Brehm, W.F.; Larrick, A.P.; Divine, J.R. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950304–3: National Association of Corrosion Engineers corrosion conference, Orlando, FL (United States), 20-25 Mar 1995). Order Number DE95002966. Source: OSTI; NTIS; INIS; GPO Dep.

The Multi-Function Waste Tank Facility carbon steel tanks will contain mixer pumps that circulate the waste. On the basis of flow characteristics of the system and data from the literature, an erosion allowance of 0.075 mm/y (3 mil/year) was recommended for the tank bottoms, in addition to the 0.025 mm/y (1 mil/year) general corrosion allowance.

5227 (WHC-SA–2624) **Hanford's Radioactive Mixed Waste Disposal Facility.** McKenney, D.E. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950216–1: Waste management '95, Tucson, AZ (United States), 26 Feb - 2 mar 1995). Order Number DE94018684. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy has been in a mode of interim storage of mixed wastes at Hanford, this facility represents the first step towards a final solution (disposal). Qualified wastes currently in storage at Hanford can now be disposed of, and development and implementation of waste treatment processes can proceed now that a facility exists which can receive mixed waste residues. Trench #31 will also allow disposal of mixed wastes resulting from remediation activities, and thus supports the Hanford Restoration mission. This facility can also serve as an important pilot test of disposal technologies to be used to support full scale remediation operations.

5228 (WHC-SA–2627) **Control system design for robotic underground storage tank inspection systems.** Kiebel, G.R. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950232–10: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95002475. Source: OSTI; NTIS; INIS; GPO Dep.

Control and data acquisition systems for robotic inspection and surveillance systems used in nuclear waste applications must be capable, versatile, and adaptable to changing conditions. The nuclear waste remediation application is dynamic – requirements

change as public policy is constantly re-examined and refocused, and as technology in this area advances. Control and data acquisition systems must adapt to these changing conditions and be able to accommodate future missions, both predictable and unexpected. This paper describes the control and data acquisition system for the Light Duty Utility Arm (LDUA) System that is being developed for remote surveillance and inspection of underground storage tanks at the Hanford Site and other US Department of Energy (DOE) sites. It is a high-performance system which has been designed for future growth. The priority mission at the Hanford site is to retrieve the waste generated by 50 years of production from its present storage and process it for final disposal. The LDUA will help to gather information about the waste and the tanks it is stored in to better plan and execute the cleanup mission.

5229 (WHC-SA–2669) **Light Duty Utility Arm System applications for tank waste remediation.** Carteret, B.A. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-950232–8: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95002478. Source: OSTI; NTIS; INIS; GPO Dep.

The Light Duty Utility Arm (LDUA) System is being developed by the US Department of Energy's (DOE's) Office of Technology Development (OTD, EM-50) to obtain information about the conditions and contents of the DOE's underground storage tanks. Many of these tanks are deteriorating and contain hazardous, radioactive waste generated over the past 50 years as a result of defense materials production at a member of DOE sites. Stabilization and remediation of these waste tanks is a high priority for the DOE's environmental restoration program. The LDUA System will provide the capability to obtain vital data needed to develop safe and cost-effective tank remediation plans, to respond to ongoing questions about tank integrity and leakage, and to quickly investigate tank events that raise safety concerns. In-tank demonstrations of the LDUA System are planned for three DOE sites in 1996 and 1997: Hanford, Idaho National Engineering Laboratory (INEL), and Oak Ridge National Laboratory (ORNL). This paper provides a general description of the system design and discusses a number of planned applications of this technology to support the DOE's environmental restoration program, as well as potential applications in other areas. Supporting papers by other authors provide additional in-depth technical information on specific areas of the system design.

5230 (WHC-SA–2709) **Team engineering for successful reuse and mission enhancement of a former DOE Weapons Material Production Facility.** Blackford, L.T. (Westinghouse Hanford Co., Richland, WA (United States)); Mizner, J.H. Jr. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-941102–37: Winter meeting of the American Nuclear Society, Washington, DC (United States), 13-18 Nov 1994). Order Number DE95003853. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes the team engineering approach used to resolve issues associated with converting a 50-year-old fuel processing facility into a decontamination facility. In only nine months, the multi-disciplinary team formed for this task has made significant progress toward both long-term and short-term goals, including conceptual design of two decontamination modules. The team's accomplishments are even more notable in light of frequent changes in scope and mission. Today, the team serves as a venue for troubleshooting operational issues, sharing vendor information, developing long-range strategies, and addressing integration issues within the facility's organizational structure. The team's approach could serve as a useful model to address the many issues surrounding the transition of the U.S. Department of Energy (DOE) and commercial complexes from a production and supply role to one of cleanup and environmental remediation.

5231 (WHC-SD-CP-OMM–003) **PFP MICON maintenance manual.** Silvan, G.R. Westinghouse Hanford Co., Richland, WA (United States). 30 Nov 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004485. Source: OSTI; NTIS; INIS; GPO Dep.

This manual covers the use of maintenance displays, maintenance procedures, system alarms and common system failures.

5232 (WHC-SD-CP-OTR–151) **Sludge stabilization operability test report.** Lewis, W.S. Westinghouse Hanford Co., Richland, WA (United States). 8 Nov 1994. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004160. Source: OSTI; NTIS; INIS; GPO Dep.

Document provides the results of the Operability Test Procedure performed to test the operability of the HC-21C thermal stabilization process for sludge. The OTP assured all equipment functioned properly and established the baseline temperature profile for glovebox HC-21C.

5233 (WHC-SD-CP-TC–031) **Heat exchanger bypass test procedure.** De Vries, M.L. Westinghouse Hanford Co., Richland, WA (United States). 15 Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004162. Source: OSTI; NTIS; INIS; GPO Dep.

The HC-21C Muffle Furnace Process has been experiencing problems with corrosion of the off-gas piping system. During the processing cycle, condensation is forming and corroding the off-gas piping. The corrosion products build up in the rotameters and cause them to be dysfunctional. The condensation is suspected to be occurring in the heat exchanger, so the test will bypass the heat exchanger to verify this. This process test will help to establish a temperature profile for the off-gas system near the rotameter. Also, this information will be used to help determine the location and cause of water condensation that is occurring in the off-gas equipment. The process test will include operating one of the two furnaces in Room 230A to stabilize Pu bearing material. During the test run, various temperature readings will be taken and visual inspections done.

5234 (WHC-SD-EN-EV–030) **Low-level waste certification plan.** Greenhalph, W.O. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004497. Source: OSTI; NTIS; INIS; GPO Dep.

This plan describes the organization and methodology for the certification of solid low-level waste (LLW) and mixed-waste (MW) generated at any of the facilities or major work activities of the Engineered Process Application (EPA) organization. The primary LLW and MW waste generating facility operated by EPA is the 377 Building. This plan does not cover the handling of hazardous or non-regulated waste, though they are mentioned at times for completeness.

5235 (WHC-SD-ETF-PLN–002) **Transition plan: Project C-018H, 200-E Area Effluent Treatment Facility.** Connor, M.D. Westinghouse Hanford Co., Richland, WA (United States). 29 Sep 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001539. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this transition plan is to ensure an orderly transfer of project information to operations to satisfy Westinghouse Hanford Company (WHC) operational requirements and objectives, and ensure safe and efficient operation of Project C-018H, the 200-E Area Effluent Treatment Facility (ETF). This plan identifies the deliverables for Project C-018H upon completion of construction and turnover to WHC for operations, and includes acceptance criteria to objectively assess the adequacy of the contract deliverables in relation to present requirements. The scope of this plan includes a general discussion of the need for complete and accurate design basis documentation and design documents as project deliverables. This plan also proposes that a configuration management plan be prepared to protect and control the transferred design documents and reconstitute the design basis and design requirements, in the event that the deliverables and project documentation received from the contractor are less than adequate at turnover.

5236 (WHC-SD-ETF-WAC–001) **Acceptance of feed streams for treatment at the LERF/ETF complex.** McDonald, F.N. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003995. Source: OSTI; NTIS; INIS; GPO Dep.

This document establishes a waste acceptance process for the storage and treatment of low-level liquid wastes in the LERF and ETF. It also discusses the steps that will be followed when evaluating a waste for storage and treatment.

5237 (WHC-SD-GN-CM–20001) **Configuration management program plan for Hanford site systems engineering.** Hoffman, A.G. Westinghouse Hanford Co., Richland, WA (United States). 14 Nov 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004489. Source: OSTI; NTIS; INIS; GPO Dep.

This plan establishes the integrated configuration management program for the evolving technical baseline developed through the systems engineering process. This configuration management program aligns with the criteria identified in the DOE Standard, DOE-STD-1073-93. Included are specific requirements for control of the systems engineering RDD-100 database, and electronic data incorporated in the database that establishes the Hanford site technical baseline.

5238 (WHC-SD-HWV-PLN–002-Rev.5) **B Plant complex hazardous, mixed and low level waste certification plan.** Beam, T.G. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004161. Source: OSTI; NTIS; INIS; GPO Dep.

This plan describes the administrative steps and handling methodology for certification of hazardous waste, mixed waste, and low level waste generated at B Plant Complex. The plan also provides the applicable elements of waste reduction and pollution prevention, including up front minimization and end product reduction of volume and/or toxicity. The plan is written to satisfy requirements for Hanford Site waste generators to have a waste certification program in place at their facility. This plan, as described, applies only to waste which is generated at, or is the responsibility of, B Plant Complex. The scope of this plan is derived from the requirements found in WHC-EP-0063, Hanford Site Solid Waste Acceptance Criteria.

5239 (WHC-SD-L045H-CSCM–001) **Treated Effluent Disposal Facility (TEDF) Operator Training Station (OTS) System Configuration Management Plan.** Carter, R.L. Jr. Westinghouse Hanford Co., Richland, WA (United States). Jun 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003778. Source: OSTI; NTIS; GPO Dep.

The Treated Effluent Disposal Facility Operator Training Station (TEDF OTS) is a computer based training tool designed to aid plant operations and engineering staff in familiarizing themselves with the TEDF Central Control System (CCS). It consists of PC compatible computers and a Programmable Logic Controller (PLC) designed to emulate the responses of various plant components connected to or under the control of the CCS. The system trains operators by simulating the normal operation but also has the ability to force failures of different equipment allowing the operator to react and observe the events. The paper describes organization, responsibilities, system configuration management activities, software, and action plans for fully utilizing the simulation program.

5240 (WHC-SD-L045H-CSDD–001) **Computer software design description for the Treated Effluent Disposal Facility (TEDF), Project L-045H, Operator Training Station (OTS).** Carter, R.L. Jr. Westinghouse Hanford Co., Richland, WA (United States). 7 Nov 1994. 278p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003065. Source: OSTI; NTIS; INIS; GPO Dep.

The Treated Effluent Disposal Facility (TEDF) Operator Training Station (OTS) is a computer-based training tool designed to aid plant operations and engineering staff in familiarizing themselves with the TEDF Central Control System (CCS).

5241 (WHC-SD-L045H-CSWD–002) **300 Area Treated Effluent Disposal Facility computer software release cover sheet and revision record.** McCarthy, R.J. Westinghouse Hanford Co., Richland, WA (United States). 28 Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004154. Source: OSTI; NTIS; INIS; GPO Dep.

This supporting document contains the computer software release cover sheet and revision records for the 300 Area Treated Effluent Disposal Facility (TEDF). The previous revision was controlled by CH2M Hill which developed the software. A 7-page listing of the contents of directory C:\TEDF is contained in this report.

5242 (WHC-SD-L045H-PLN–004) **300 Area TEDF NPDES Permit Compliance Monitoring Plan.** Loll, C.M. Westinghouse Hanford Co., Richland, WA (United States). 13 Oct 1994. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95002070. Source: OSTI; NTIS; INIS; GPO Dep.

This monitoring plan describes the activities and methods that will be employed at the 300 Area Treated Effluent Disposal Facility (TEDF) in order to ensure compliance with the National Discharge Elimination System (NPDES) permit. Included in this document are a brief description of the project, the specifics of the sampling effort, including the physical location and frequency of sampling, the support required for sampling, and the Quality Assurance (QA) protocols to be followed in the sampling procedures.

5243 (WHC-SD-L045H-RPT–001) **300 Area TEDF DOE order compliance applicability assessment.** Eacker, J.A. Westinghouse Hanford Co., Richland, WA (United States). 8 Nov 1994. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003779. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the results of an effort to determine applicability of Department of Energy Orders at the Hanford 300 Area Treated Effluent Disposal Facility (TEDF). This assessment placed each of the reviewed orders into one of three compliance categories: (A) order applicable at a facility specific level (20 identified); (B) order applicable at a policy level (11 identified); or (C) order not applicable (21 identified). The scope of the assessment from the DOE Order standpoint was the 52 Level 1 Orders of interest to the Defense Nuclear Facility Safety Board (DNFSB). Although the TEDF is a non-nuclear facility, this order basis was chosen as a Best Management Practice to be consistent with ongoing efforts across the Hanford Site. Three tables in the report summarize the DOE order applicability by the compliance categories, with a table for Level A, Level B, and Level C applicability. The attachment to the report documents the compliance applicability assessment for each individual DOE Order.

5244 (WHC-SD-L045H-RRR–001-Rev.1) **Readiness plan, Hanford 300 Area Treated Effluent Disposal Facility: Revision 1.** Storm, S.J. Westinghouse Hanford Co., Richland, WA (United States). 8 Nov 1994. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003775. Source: OSTI; NTIS; INIS; GPO Dep.

The 300 Area Treated Effluent Disposal Facility (TEDF) is designed for the collection, treatment, and eventual disposal of liquid waste from the 300 Area Process Sewer (PS) system. The PS currently discharges water to the 300 Area Process Trenches. Facilities supported total 54 buildings, including site laboratories, inactive buildings, and support facilities. Effluent discharges to the process sewer from within these facilities include heating, ventilation, and air conditioning systems, heat exchangers, floor drains, sinks, and process equipment. The wastewaters go through treatment processes that include iron coprecipitation, ion exchange and ultraviolet oxidation. The iron coprecipitation process is designed to remove general heavy metals. A series of gravity filters then complete the clarification process by removing suspended solids. Following the iron coprecipitation process is the ion exchange process, where a specific resin is utilized for the removal of mercury. The final main unit operation is the ultraviolet destruction process, which uses high power ultraviolet light and hydrogen peroxide to destroy organic molecules. The objective of this readiness plan is to provide the method by which line management will prepare for a

Readiness Assessment (RA) of the TEDF. The self-assessment and RA will assess safety, health, environmental compliance and management readiness of the TEDF. This assessment will provide assurances to both WHC and DOE that the facility is ready to start-up and begin operation.

5245 (WHC-SD-SNF-FDC–001) **Gas and liquid sampling for closed canisters in K-West basins - functional design criteria.** Pitkoff, C.C. Westinghouse Hanford Co., Richland, WA (United States). 27 Jul 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003253. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to provide functions and requirements for the design and fabrication of equipment for sampling closed canisters in the K-West basin. The samples will be used to help determine the state of the fuel elements in closed canisters. The characterization information obtained will support evaluation and development of processes required for safe storage and disposition of Spent Nuclear Fuel (SNF) materials.

5246 (WHC-SD-SNF-FVP–001) **K Basins Field Verification Program.** Booth, H.W. Westinghouse Hanford Co., Richland, WA (United States). 2 Dec 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004366. Source: OSTI; NTIS; INIS; GPO Dep.

The Field Verification Program establishes a uniform and systematic process to ensure that technical information depicted on selected engineering drawings accurately reflects the actual existing physical configuration. This document defines the Field Verification Program necessary to perform the field walkdown and inspection process that identifies the physical configuration of the systems required to support the mission objectives of K Basins. This program is intended to provide an accurate accounting of the actual field configuration by documenting the as-found information on a controlled drawing.

5247 (WHC-SD-SNF-TRP–001) **Cold test data for equipment acceptance into 105-KE Basin.** Packer, M.J. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004151. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides acceptance testing of equipment to be installed in the 105-KE Basin for pumping sludge to support the discharge chute barrier doors installation.

5248 (WHC-SD-SNF-UM–002) **MBA, mass balance area user guide.** Russell, V.K. Westinghouse Hanford Co., Richland, WA (United States). 22 Sep 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004105. Source: OSTI; NTIS; GPO Dep.

This document presents the Mass BAlance (MBA) database system user instructions which explain how to record the encapsulation activity from the K Basin as it is being performed on the computer, activity associated with keeping the work area safe from going critical, and administrative functions associated with the system. This document includes the user instructions, which also serve as the software requirements specification for the system implemented on the microcomputer. This includes suggested user keystrokes, examples of screens displayed by the system, and reports generated by the system. It shows how the system is organized, via menus and screens. It does not explain system design nor provide programmer instructions. MBA was written to equip the personnel performing K-Basin encapsulation tasks with a conservative estimate of accumulated mass during the processing of canisters into and out of the chute, primarily in the K-East basin.

5249 (WHC-SD-W025-ATR–001-Rev.1) **W-025, acceptance test report.** Roscha, V. Westinghouse Hanford Co., Richland, WA (United States). 4 Oct 1994. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004111. Source: OSTI; NTIS; INIS; GPO Dep.

This acceptance test report (ATR) has been prepared to establish the results of the field testing conducted on W-025 to demonstrate that the electrical/instrumentation systems functioned as intended by design. This is part of the RMW Land Disposal Facility.

5250 (WHC-SD-W025-EMS–002) **Weight/balance portable test equipment.** Whitlock, R.W. Westinghouse Hanford Co., Richland, WA (United States). 3 Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003846. Source: OSTI; NTIS; INIS; GPO Dep.

This document shows the general layout, and gives a part description for the weight/balance test equipment. This equipment will aid in the regulation of the leachate loading of tanker trucks. The report contains four drawings with part specifications. The leachate originates from lined trenches.

5251 (WHC-SD-W025-EMS–002-Rev.1) **Weight/balance portable test equipment.** Whitlock, R.W. Westinghouse Hanford Co., Richland, WA (United States). 30 Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004471. Source: OSTI; NTIS; INIS; GPO Dep.

This document shows the general layout, and gives a part description for the Weight/Balance Test Equipment.

5252 (WHC-SD-W025-PLN–002) **Readiness assessment plan for the Radioactive Mixed Waste Land Disposal Facility (Trench 31).** Irons, L.G. Westinghouse Hanford Co., Richland, WA (United States). 22 Nov 1994. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003306. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the Readiness Assessment Plan (RAP) for the Project W-025 (Radioactive Mixed Waste Land Disposal Facility) Readiness Assessment (RA). The RAP documents prerequisites to be met by the operating organization prior to the RA. The RAP is to be implemented by the RA Team identified in the RAP. The RA Team is to verify the facility's compliance with criteria identified in the RAP. The criteria are based upon the "Core Requirements" listed in DOE Order 5480.31, "Startup and Restart of Nuclear Facilities".

5253 (WHC-SD-W025-VI–001-Rev.1) **Leachate storage transport tanker loadout piping.** Whitlock, R.W. Westinghouse Hanford Co., Richland, WA (United States). 18 Nov 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004158. Source: OSTI; NTIS; INIS; GPO Dep.

This report shows the modifications to the W-025 Trench No. 31 leachate loadout discharge piping, and also the steps involved in installing the discharge piping, including dimensions and welding information. The installation of the discharge pipe should be done in accordance to current pipe installation standards. Trench No. 31 is a radioactive mixed waste land disposal facility.

5254 (WHC-SD-W026-ES–013) **WRAP Module 1 sampling strategy and waste characterization alternatives study.** Bergeson, C.L. Westinghouse Hanford Co., Richland, WA (United States). 30 Sep 1994. 204p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003055. Source: OSTI; NTIS; INIS; GPO Dep.

The Waste Receiving and Processing Module 1 Facility is designed to examine, process, certify, and ship drums and boxes of solid wastes that have a surface dose equivalent of less than 200 mrem/h. These wastes will include low-level and transuranic wastes that are retrievably stored in the 200 Area burial grounds and facilities in addition to newly generated wastes. Certification of retrievably stored wastes processing in WRAP 1 is required to meet the waste acceptance criteria for onsite treatment and disposal of low-level waste and mixed low-level waste and the Waste Isolation Pilot Plant Waste Acceptance Criteria for the disposal of TRU waste. In addition, these wastes will need to be certified for packaging in TRUPACT-II shipping containers. Characterization of the retrievably stored waste is needed to support the certification process. Characterization data will be obtained from historical records, process knowledge, nondestructive examination nondestructive assay, visual inspection of the waste, head-gas sampling, and analysis of samples taken from the waste containers. Sample characterization refers to the method or methods that are used to test waste samples for specific analytes. The focus of this study is the sample characterization needed to accurately identify the hazardous and radioactive constituents present in the retrieved wastes

that will be processed in WRAP 1. In addition, some sampling and characterization will be required to support NDA calculations and to provide an over-check for the characterization of newly generated wastes. This study results in the baseline definition of WRAP 1 sampling and analysis requirements and identifies alternative methods to meet these requirements in an efficient and economical manner.

5255 (WHC-SD-W026-PLN–004) **Implementation plan for WRAP Module 1 operational readiness review.** Irons, L.G. Westinghouse Hanford Co., Richland, WA (United States). 4 Nov 1994. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003844. Source: OSTI; NTIS; INIS; GPO Dep.

The Waste Receiving and Processing Module 1 (WRAP 1) will be used to receive, sample, treat, and ship contact-handled (CH) transuranic (TRU), low-level waste (LLW), and low-level mixed waste (LLMW) to storage and disposal sites both on the Hanford site and off-site. The primary mission of WRAP 1 is to characterize and certify CH waste in 55-gallon and 85-gallon drums; and its secondary function is to certify CH waste standard waste boxes (SWB) and boxes of similar size for disposal. The WRAP 1 will provide the capability for examination (including x-ray, visual, and contents sampling), limited treatment, repackaging, and certification of CH suspect-TRU waste in 55-gallon drums retrieved from storage, as well as newly generated CH LLW and CH TRU waste drums. The WRAP 1 will also provide examination (X-ray and visual only) and certification of CH LLW and CH TRU waste in small boxes. The decision to perform an Operational Readiness Review (ORR) was made in accordance with WHC-CM-5-34, Solid Waste Disposal Operations Administration, Section 1.4, Operational Readiness Activities. The ORR will ensure plant and equipment readiness, management and personnel readiness, and management programs readiness for the initial startup of the facility. This implementation plan is provided for defining the conduct of the WHC ORR.

5256 (WHC-SD-W026-SDP–001) **Waste receiving and processing facility module 1 data management system software project management plan.** Clark, R.E. Westinghouse Hanford Co., Richland, WA (United States). 2 Nov 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004108. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the software development plan for the Waste Receiving and Processing (WRAP) Module 1 Data Management System (DMS). The DMS is one of the plant computer systems for the new WRAP 1 facility (Project W-026). The DMS will collect, store, and report data required to certify the low level waste (LLW) and transuranic (TRU) waste items processed at WRAP 1 as acceptable for shipment, storage, or disposal.

5257 (WHC-SD-W049H-ATP–002) **Project W-049H collection system Acceptance Test Procedure.** Carrigan, M.C. (Westinghouse Hanford Co., Richland, WA (United States)). Westinghouse Hanford Co., Richland, WA (United States); ICF Kaiser Hanford Co., Richland, WA (United States). 11 Nov 1994. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003764. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this Acceptance Test Procedure (ATP) for the Project W-049H, Treated Effluent Disposal Facility, is to verify that the collection system equipment installed as Pump Station No. 1 (225-W) and Pump Station No. 2 (225-E) have been installed in accordance with the design documents and function as required by the project criteria. This will be a wet test with potable water being introduced into the pump pits to test for leakage. Potable water will also be employed in the testing of the pumps and related mechanical equipment. All Instrument and Control equipment related to the pump stations will be checked electronically with simulated inputs/outputs when actual input/output signals are unavailable. Water from Pump Station 1 will be moved through the TEDF piping system and discharged into the disposal ponds. This will check the proper function of the air/vac valves not tested during construction, and the automated samplers.

5258 (WHC-SD-W049H-ATP–003) **Project W-049H instrument and control Acceptance Test Procedure.** Carrigan, M.C. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1994. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003763. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this Acceptance Test Procedure (ATP) for the Project W-049H, Treated Effluent Disposal Facility, is to verify that the instrument and control systems have been installed in accordance with the design documents and function as required by the project criteria. The instrument and control system includes three operator control stations, modems, and general purpose LAN interface cabinets in the Effluent Treatment Facility control room; two pump stations; disposal station pumping building; and all local control units installed in the fold. Testing will be performed using actual signals when available and simulated signals when actual signals are unavailable.

5259 (WHC-SD-W049H-CSRS–001) **Treated effluent disposal system process control computer software requirements and specification.** Graf, F.A. Jr. Westinghouse Hanford Co., Richland, WA (United States). 3 Jun 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004470. Source: OSTI; NTIS; INIS; GPO Dep.

The software requirements for the monitor and control system that will be associated with the effluent collection pipeline system known as the 200 Area Treated Effluent Disposal System is covered. The control logic for the two pump stations and specific requirements for the graphic displays are detailed.

5260 (WHC-SD-W087-FDC–001-Rev.3) **Functional design criteria radioactive liquid waste line replacement, Project W-087. Revision 3.** McVey, C.B. Westinghouse Hanford Co., Richland, WA (United States). 13 Oct 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003051. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the functional design criteria for the 222-S Laboratory radioactive waste drain piping and transfer pipeline replacement. The project will replace the radioactive waste drain piping from the hot cells in 222-S to the 219-S Waste Handling Facility and provide a new waste transfer route from 219-S to the 244-S Catch Station in Tank Farms.

5261 (WHC-SD-W100-DTR–003) **Waste receiving and processing module 2A mixing tests status report.** Weber, J.R.; Hull, K.J. Westinghouse Hanford Co., Richland, WA (United States). 18 Nov 1994. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004418. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this report is to document the Phase II test conditions, observations, and results of this work. This report provides additional mixing performance test data and rheologic data that provide further indications that there are clear and distinct advantages in the preliminary choice of high-shear mixing alone, and high-shear dispersion in combination with, or followed by, a low-speed type mixer/stirrer for WRAP 2A facility design. Another objective was to determine if significant scale-up problems might exist in the various mix and mixer designs. In the later Phase 2 tests the test material quantities were significantly larger than in the Phase 1 tests.

5262 (WHC-SD-W100-ES–009) **Application of DOE prescribed guides to the evaluation of Hanford's Mixed Low Level Solid Waste Treatment Options.** Campbell, B.F.; Nash, C.R. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004103. Source: OSTI; NTIS; INIS; GPO Dep.

A recent Westinghouse Hanford Company report (WHC-SD-W100-ES-008, February, 1994), compared a Vitrification process to the WRAP-2A Grout/PE process for the treatment of Mixed Low Level Waste (MLLW). This comparison applied a limited scope numerical evaluation to compare technology complexity of the two processes, but focused primarily on capital and operating costs. The work reported here is supplementary to WHC-SD-WI00-ES-008. It provides a record of the application of the more formal

DOE-prescribed criteria (Treatment Selection Guides for Federal Facility Compliance Act Draft Site Treatment Plans) to the Vitrification and Grout/PE processes previously evaluated. Results of the evaluation favored the Grout/PE process by a weighted score of 83 to 78 over the Plasma arc vitrification process.

5263 (WHC-SD-W100-RD–001-Rev.1) **Waste Receiving and Processing, Module 2A, feed specification: Revision 1.** Kruger, O.L.; Sheriff, M.L. Westinghouse Hanford Co., Richland, WA (United States). 14 Nov 1994. 186p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003782. Source: OSTI; NTIS; INIS; GPO Dep.

Detailed descriptions of the various mixed low-level waste feed streams that will be processed in the Waste Receiving and Processing Facility, Module 2A (WRAP 2A) are provided. Feed stream descriptions are based on available reports, the solid waste information tracking system database, and the 1993 solid waste forecast data. Available chemical and physical attributes, radionuclide data, waste codes, and packaging information are shown for 15 feed streams. The information sources and methodology for obtaining projections for WRAP 2A expected feed stream volumes also are described.

5264 (WHC-SD-W100-WP–007) **Work plan for waste receiving and processing module 2A waste characterization study.** Bergeson, C.L. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004425. Source: OSTI; NTIS; INIS; GPO Dep.

This WRAP 2A Waste Characterization Study effort addresses those certification strategy functions related to characterization by defining criteria associated with each function, identifying administrative and design mechanisms for accomplishing each of these functions and evaluating alternatives where applicable. This work plan provides direction for completing the study.

5265 (WHC-SD-W105-OTR–003) **Operational test report for LERF Basin 242AL-44 integrity test.** Galioto, T.M. Westinghouse Hanford Co., Richland, WA (United States). 8 Nov 1994. 69p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003851. Source: OSTI; NTIS; INIS; GPO Dep.

This operational test report documents the results of LERF operational testing per operational test procedure (OTP) TFPE-WP-0231, "LERF Basin Integrity Testing." The primary purpose of the OTP was to resolve test exceptions generated as a result of TFPE-WP-0184. The TOP was prepared and performed in accordance with WHC-SD-534-OTP-002, "Operational Test Plan for the 242-A Evaporator Upgrades and the Liquid Effluent Retention Facility." WHC-S-086, "Specification for Operational Testing of the Liquid Effluent Retention Facility, Basin Integrity Testing," identified the test requirements and acceptance criteria. The completed, signed-off test procedure is contained in Appendix A. The test log is contained in Appendix B. Section 2.1 describes all the test exceptions written during performance of the Operational Test Procedure. The test revisions generated during the testing are discussed in Section 2.2. The dispositioned test exception forms are contained in Appendix C.

5266 (WHC-SD-W151-QAPP–001-Rev.2) **Project specific quality assurance plan, W-151, Tank 241-AZ-101 waste retrieval system. Revision 2.** Manthei, M.E. Westinghouse Hanford Co., Richland, WA (United States). 21 Nov 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004361. Source: OSTI; NTIS; GPO Dep.

This project specific quality assurance program plan establishes the responsibility for the implementation of QA requirements, defines and documents the QA requirements associated with design, procurement, and construction, and defines and documents the degree of QA reviews and verifications on the design and construction necessary to assure compliance to project and DOE requirements. Revision 2 updates the QAPP to provide concurrence with approved work scope deletion. In addition, the Quality Assurance Program Index is being updated to reflect the current Quality Assurance Program requirements per DOE Order 5700.6C.

5267 (WHC-SD-W151-TI–002) **Dose rate analysis for Tank 101 AZ (Project W151).** Schwarz, R.A.; Hillesland, K.E.; Carter, L.L. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 59p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004363. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes the expected dose rates for modification to tank 101 AZ including modifications to the steam coil, mixer pump, and temperature probes. The thrust of the effort is to determine dose rates from: modification of a steam coil and caisson; the installation of mixer pumps; the installation of temperature probes; and estimates of dose rates that will be encountered while making these changes. Because the dose rates for all of these configurations depend upon the photon source within the supernate and sludge, comparisons were also made between measured dose rates within a drywell and the corresponding calculated dose rates. The calculational tool used is a Monte Carlo ($MCNP_2$) code since complicated three dimensional geometries are involved. A summary of the most important results of the entire study is given in Section 2. The basic calculational geometry model of the tank is discussed in Section 3, along with a tabulation of the photon sources that were used within the supernate and the sludge, and a discussion of uncertainties. The calculated dose rates around the steam coil and caisson before and after modification are discussed in Section 4. The configuration for the installation of the mixer pumps and the resulting dose rates are given in Section 5. The predicted changes in dose rates due to a possible dilution of the supernate source are given in Section 6. The calculational configuration used to model the installation of temperature probes and the resulting predicted dose rates are discussed in Section 7. Finally, comparisons of measured to calculated dose rates within a drywell are summarized in Section 8. Extended discussions of calculational models and Monte Carlo optimization techniques used are included in Appendix A.

5268 (WHC-SD-W236A-ER–010) **Multi-Function Waste Tank Facility thermal hydraulic analysis for Title II design.** Cramer, E.R. Westinghouse Hanford Co., Richland, WA (United States). 10 Nov 1994. 65p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003871. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this work was to provide the thermal hydraulic analysis for the Multi-Function Waste Tank Facility (MWTF) Title II design. Temperature distributions throughout the tank structure were calculated for subsequent use in the structural analysis and in the safety evaluation. Calculated temperatures of critical areas were compared to design allowables. Expected operating parameters were calculated for use in the ventilation system design and in the environmental impact documentation. The design requirements were obtained from the MWTF Functional Design Criteria (FDC). The most restrictive temperature limit given in the FDC is the 200 limit for the haunch and dome steel and concrete. The temperature limit for the rest of the primary and secondary tanks and concrete base mat and supporting pad is 250 F. Also, the waste should not be allowed to boil. The tank geometry was taken from ICF Kaiser Engineers Hanford drawing ES-W236A-Z1, Revision 1, included here in Appendix B. Heat removal rates by evaporation from the waste surface were obtained from experimental data. It is concluded that the MWTF tank cooling system will meet the design temperature limits for the design heat load of 700,000 Btu/h, even if cooling flow is lost to the annulus region, and temperatures change very slowly during transients due to the high heat capacity of the tank structure and the waste. Accordingly, transients will not be a significant operational problem from the viewpoint of meeting the specified temperature limits.

5269 (WHC-SD-W236A-ER–014) **Computer code input for thermal hydraulic analysis of Multi-Function Waste Tank Facility Title II design.** Cramer, E.R. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 514p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004430. Source: OSTI; NTIS; INIS; GPO Dep.

The input files to the P/Thermal computer code are documented for the thermal hydraulic analysis of the Multi-Function Waste Tank Facility Title II design analysis.

5270 (WHC-SD-W236A-RPT–004) **The Multi-Function Waste Tank Facility (MWTF) surplus equipment report.** Cruz, V.J.; Epperson, E.M. Westinghouse Hanford Co., Richland, WA (United States). 14 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004110. Source: OSTI; NTIS; GPO Dep.

This report documents the methods that were utilized to obtain information about the availability and location of government excess equipment. It will also list excess/underused equipment that could/will be appropriated for use under Project W-236 procurement actions.

5271 (WHC-SD-W236A-TI–016) **Seismic design spectra 200 West and East Areas DOE Hanford Site, Washington.** Tallman, A.M. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 79p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003858. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents equal hazard response spectra for the W236A project for the 200 East and West new high-level waste tanks. The hazard level is based upon WHC-SD-W236A-TI-002, Probabilistic Seismic Hazard Analysis, DOE Hanford Site, Washington. Spectral acceleration amplification is plotted with frequency (Hz) for horizontal and vertical motion and attached to this report. The vertical amplification is based upon the preliminary draft revision of Standard ASCE 4-86. The vertical spectral acceleration is equal to the horizontal at frequencies above 3.3Hz because of near-field, less than 15 km, sources.

5272 (WHC-SD-W236B-FRD–002-Rev.1) **Functions and requirements for Project W-236B, Initial Pretreatment Module: Revision 1.** Swanson, L.M. Westinghouse Hanford Co., Richland, WA (United States). 22 Nov 1994. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004146. Source: OSTI; NTIS; INIS; GPO Dep.

Hanford Site tank waste supernatants will be pretreated to separate the low-level and high-level fractions. The low-level waste fraction, containing the bulk of the chemical constituents, must be processed into a vitrified waste product which will be disposed of onsite, in a safe, environmentally sound, and cost effective manner. The high-level waste fraction separated during supernatant pretreatment (primarily cesium) will be recombined with an additional high-level waste fraction generated from pretreatment of the tank waste sludges and solids. This combined high-level waste fraction will be immobilized as glass and disposed in a geological repository. The purpose of this document is to establish the functional requirements baseline for Project W-236B, Initial Pretreatment Module, by defining the level 5 and 6 functions and requirements for the project. A functional analysis approach has been used to break down the program functions and associated physical requirements that each function must meet. As the systems engineering process evolves, the design requirements document will replace this preliminary functions and requirements document. The design requirements document (DRD) will identify key decisions and associated uncertainties that impact the project. A revision of this document to a DRD is not expected to change the performance requirements or open issues. However, additional requirements and issues may be identified.

5273 (WHC-SD-W242-ES–003) **Low level mixed waste thermal treatment technical basis report.** Place, B.G. Westinghouse Hanford Co., Richland, WA (United States). Dec 1994. 78p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003869. Source: OSTI; NTIS; INIS; GPO Dep.

Detailed characterization of the existing and projected Hanford Site Radioactive Mixed Waste (RMW) inventory was initiated in 1993 (Place 1993). This report presents an analysis of the existing and projected RMW inventory. The subject characterization effort continues to be in support of the following engineering activities related to thermal treatment of Hanford Site RMW: (1) Contracting for commercial thermal treatment; (2) Installation and operation of an onsite thermal treatment facility (Project W-242); (3) Treatment at another Department of Energy (DOE) site. The collation of this characterization information (data) has emphasized the establishment of a common data base for the entire existing RMW inventory so that the specification of feed streams destined for different treatment facilities can be coordinated.

5274 (WHC-SD-W252-FDC–001-Rev.1) **Functional design criteria for Project W-252, Phase II Liquid Effluent Treatment and Disposal: Revision 1.** Hatch, C.E. Westinghouse Hanford Co., Richland, WA (United States). 10 Nov 1994. 69p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003838. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the functional design criteria required for the Phase 2 Liquid Effluent Treatment and Disposal Project, Project W-252. Project W-252 shall provide new facilities and existing facility modifications required to implement Best Available Technology/All Known, Available, and Reasonable Methods of Prevention, Control, and Treatment (BAT/AKART) for the 200 East Phase II Liquid Effluent Streams. The project will also provide a 200 East Area Phase II Effluent Collection System (PTECS) for connection to a disposal system for relevant effluent streams to which BAT/AKART has been applied. Liquid wastestreams generated in the 200 East Area are currently discharged to the soil column. Included in these wastestreams are cooling water, steam condensate, raw water, and sanitary wastewaters. It is the policy of the DOE that the use of soil columns to treat and retain radionuclides and nonradioactive contaminants be discontinued at the earliest practical time in favor of wastewater treatment and waste minimization. In 1989, the DOE entered into an interagency agreement with Ecology and EPA. This agreement is referred to as the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement). Project W-252 is one of the projects required to achieve the milestones set forth in the Tri-Party Agreement. One of the milestones requires BAT/AKART implementation for Phase II streams by October 1997. This Functional Design Criteria (FDC) document provides the technical baseline required to initiate Project W-252 to meet the Tri-Party Agreement milestone for the application of BAT/AKART to the Phase II effluents.

5275 (WHC-SD-W340-WP–002) **Permitting plan for Project W-340, Tank 241-C-106 manipulator retrieval arm.** Tollefson, K.S. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 35p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004498. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes the regulatory requirements and describes alternative strategies for obtaining permits and approvals for Project W-340, Tank 241-C-106 Manipulator Retrieval Arm. A comprehensive review of environmental regulations has indicated that several environmental reviews, permits, and approvals are required before design, construction, and operation of the facility. The environmental reviews, permits, and approvals, as well the regulatory authority potentially applicable to the Project W-340 Long Reach Manipulator Arm include the following: National Environmental Policy Act of 1969 – US Department of Energy, Headquarters; State Environmental Policy Act of 1971 – State of Washington Department of Ecology; Air Permitting; Dangerous Waste Permitting; Miscellaneous Reviews/Permits/Approvals. This document describes the environmental reviews, permits, and approval requirements for the project. It provides a summary of permit application data requirements, alternative strategies for permit completion and approval, as well as the estimated probability of success for each alternative strategy.

5276 (WHC-SD-W370-ER–001) **Recommendation for sanitary waste water system replacement, 222-S.** Simmons, F.M. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003863. Source: OSTI; NTIS; INIS; GPO Dep.

The 2607-W6 septic system is not approved by the Washington State Department of Health. The system is over 40 years old and is operating at greater than 200% capacity. Under these conditions the system is subject to imminent failure and is not adequately treating the septic waste. This poses a potential personnel health risk. It is recommended that this system be upgraded by installation of a new drain field similar to the modification of the 2607-W1 system.

5277 (WHC-SD-W370-FDC–001) **2607-W6 sanitary drainfield replacement.** Simmons, F.M. Westinghouse Hanford Co., Richland, WA (United States). May 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003864. Source: OSTI; NTIS; INIS; GPO Dep.

The septic 2607-W6 which supports the 222-S complex is operating at 200% capacity. The septic tank has been inspected and found to be sound. Test hole excavations of the existing drainfield indicate that it is disposing of the current waste water effluent load as opposed to treating it. The system is over 40 years old and has not been approved by the Washington State Department of Health. Under the existing operating conditions it is subject to imminent failure. No additional tie-ins or increases in personnel are allowed which will increase the flow to the 2607-W6 system.

5278 (WHC-SD-WM-ANAL–036) **241-SY modular exhauster pad analysis.** Kriskovich, J.R. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1994. 144p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004157. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to show the analytical results which were reached in analyzing the new 241-SY modular exhauster concrete pad and retaining wall. The analysis covers wind loading (80 mph), an equivalent static load due to a seismic event, and from those two results, a determination of the pad thickness and the location and size of reinforcement bar was made. The analysis of the exhauster assembly and sampling cabinet evaluated overturning of the assemblies as a whole. An analysis was then performed for the bolting requirements for these two assemblies. The reason why this was broken up into components was to determine if the individual components could take the load exerted by the workset case loading condition, whether it be wind or seismic. The retaining wall that will be located near the new concrete pad was also analyzed. The retaining wall was evaluated to determine the area of reinforcement required, the location of reinforcement, as well as the mass and configuration of the wall to prevent overturning or sliding. The wall was considered Non-Safety Class 4. Additional piping was required to tie-in the new exhauster to the existing primary ventilation ductwork. The design for the tie-in includes two butterfly valves, a tee fitting, elbows, flanges, straight pipe sections, and two new pipe supports to accommodate the additional weight. The valves will enable the new and existing exhausters to be isolated independently. The ductwork, couplings, and supports were analyzed for structural adequacy given Safety Class 2 loads.

5279 (WHC-SD-WM-AP–029) **Boundry description for removal of water cooled chillers.** Thompson, M.W. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003279. Source: OSTI; NTIS; INIS; GPO Dep.

This SD describes the boundaries for removal of the water cooled chillers by projects. In this paper, the author defines K Basins Engineering and project responsibilities for removal of the Trane.

5280 (WHC-SD-WM-AP–031) **Double shell tanks emergency pumping plan.** Tangen, M.J. Westinghouse Hanford Co., Richland, WA (United States). 26 Sep 1994. 82p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001376. Source: OSTI; NTIS; INIS; GPO Dep.

At the request of the Department of Energy (DOE), a formal plan for the emergency transfer of waste from a leaking double shell tank to a designated receiver tank has been developed. This plan is in response to the priority 2 safety issue "Response to a leaking double-shell tank" in the DOE Report to Congress, 1991. The plan includes the tanks in four of the east tank farms and one of the west farms. The background information and supporting calculations used for the creation of the emergency plan are discussed in this document. The scope of this document is all of the double shell tanks in the AN, AP, AW, AY, and SY farms. The transfer lines, flush pits, and valve pits involved in the transfer of waste between these farms are also included in the scope. Due to the storage of high heat waste, AZ farm is excluded at this time.

5281 (WHC-SD-WM-ATP–023-Rev.6) **Tank Monitor and Control System sensor acceptance test procedure. Revision 6.** Scaief, C.C. III. Westinghouse Savannah River Co., Aiken, SC (United States). 2 Nov 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003063. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this Acceptance Test Procedure (ATP) is to verify the correct reading of sensor elements connected to the Tank Monitor and Control System (TMACS). The system functional requirements are contained in WHC-SD-WM-RD-013, Rev. 1 (WHC 1992a). This ATP is intended to be used for testing of the connection of existing temperature sensors, new temperature sensors, pressure sensing equipment, new Enraf level gauges, sensors that generate a current output, and discrete (on/off) inputs. The TMACS operation was verified by the original ATP (WHC 1991 c). It is intended that this ATP will be used each time sensors are added to the system. As a result, the data sheets have been designed to be generic.

5282 (WHC-SD-WM-ATP–069-Rev.2) **Acceptance test procedure for tank bottom thermocouples on Tank 241-SY-101. Revision 2.** Zuehlke, A.C. Westinghouse Hanford Co., Richland, WA (United States). 25 Oct 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003158. Source: OSTI; NTIS; INIS; GPO Dep.

This ECN incorporates a complete procedure revision for testing the re-installation of a temporary Data Logger which is to be installed in support of upcoming mixer pump excavation runs.

5283 (WHC-SD-WM-ATP–107) **MIT upgrade acceptance test procedure.** Zuehlke, A.C. Westinghouse Hanford Co., Richland, WA (United States). 10 Oct 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003276. Source: OSTI; NTIS; INIS; GPO Dep.

This procedure will test the 17B MIT sensor inputs to the DACS trailer after installation of new thermocouple multiplexers and associated computer software.

5284 (WHC-SD-WM-ATP–111-Rev.1) **Rotary mode core sampling service trailer Acceptance Test Plan.** Kostelnik, A.J. Westinghouse Hanford Co., Richland, WA (United States). 28 Nov 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004419. Source: OSTI; NTIS; GPO Dep.

This Acceptance Test Procedure (ATP) will document compliance with the requirements of specification WHC-S-056 Rev.2 including ECNs 608798 and 616386. The equipment being tested is a furniture type trailer with storage cabinets, lighting and HVAC systems installed. The unit was purchased as a Design and Fabrication procurement activity. The ATP be performed by representatives of the Westinghouse Hanford Company with the assistance of the Seller at the Seller's location.

5285 (WHC-SD-WM-ATP–112) **Factory Acceptance Test Procedure Westinghouse 100 ton Hydraulic Trailer.** Aftanas, B.L. (Westinghouse Hanford Co., Richland, WA (United States)). Westinghouse Hanford Co., Richland, WA (United States); Kamp Systems, Ontario, CA (United States). 16 Nov 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003781. Source: OSTI; NTIS; INIS; GPO Dep.

This Factory Acceptance Test Procedure (FAT) is for the Westinghouse 100 Ton Hydraulic Trailer. The trailer will be used for the removal of the 101-SY pump. This procedure includes: safety check and safety procedures; pre-operation check out; startup; leveling trailer; functional/proofload test; proofload testing; and rolling load test.

5286 (WHC-SD-WM-CSWD–067) **System verification and validation plan for SY-101 Hydrogen Mitigation Test Project Data Acquisition and Control System (DACS-1).** McNeece, S.G.; Truitt, R.W. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 12p. Sponsored by USDOE, Washington, DC

(United States). DOE Contract AC06-87RL10930. Order Number DE95003639. Source: OSTI; NTIS; INIS; GPO Dep.

This document outlines the system verification and validation plan for the SY-101 DACS, covering the operation and maintenance phase of the project life cycle.

5287 (WHC-SD-WM-DA–166) **Analysis of BY-106 pump pit cover plate.** Coverdell, B.L. Westinghouse Hanford Co., Richland, WA (United States). 14 Nov 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003856. Source: OSTI; NTIS; INIS; GPO Dep.

A new cover for the pump pit of Tank 241-BY-106 has been designed to allow the rotary core exhauster to be hooked up without requiring pit entry, riser modification, or equipment removal. The new pit cover is necessary to allow installation of two risers for reducing exposure, contamination, and waste. Computer analysis indicates that the safety margin of the pit cover plate with two risers is adequate. The computer stress model and input files are attached. The pit cover plate is a replacement for an existing plate; therefore seismic and wind loads were considered for the plate only.

5288 (WHC-SD-WM-DB–024) **Design basis and requirements for 241-SY Modular Exhauster concrete pad and retaining wall.** Kriskovich, J.R. Westinghouse Hanford Co., Richland, WA (United States). 1 Nov 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003083. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to serve as the design and functional requirements for a concrete pad for the new 241-SY Modular Exhauster and for a retaining wall to be built near the new ventilation systems.

5289 (WHC-SD-WM-DB–025) **Design basis and requirements for 241-SY modular exhauster mechanical installation.** Kriskovich, J.R. Westinghouse Hanford Co., Richland, WA (United States). 10 Nov 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003849. Source: OSTI; NTIS; INIS; GPO Dep.

A new ventilation system is being installed to serve as the K-1 primary exhauster. The existing K-1 primary exhauster will then become the backup. This ventilation system services waste tanks 241-SY-101, 102 and 103. The nominal flow rate through the ventilation system is 1,000 cfm. The new ventilation system will contain a moisture eliminator, a heater, a prefilter, two stages of HEPA filtration, an exhaust fan, a stack and stack sampling system. The purpose of this document is to serve as the design and functional requirements for the mechanical installation of the new 241-SY modular exhauster. The mechanical installation will include modifying the existing ductwork (i.e., installing a "T" to connect the new exhauster to the existing system), modifying the existing condensate drain lines to accommodate the new lines associated with the new exhauster, a maintenance platform near the stack of the new exhauster, guy wires and guy wire footings to support the stack of the new exhauster, as well as other miscellaneous tasks associated with the mechanical installation design effort.

5290 (WHC-SD-WM-DP–0076) **45-Day deliverable for Tank 241-BX-105 Auger samples, risers 2 and 6.** Bell, K.E. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1994. 116p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003999. Source: OSTI; NTIS; INIS; GPO Dep.

Two auger samples from single-shell tank 241-BX-105 (BX-105) were extruded, broken down, and analyzed for DSC, TGA, and total alpha as prescribed. Analytical results were tracked and reported using the laboratory information management system known as LabCore. This is the final report for the fiscal year 1995 BX-105 auger sample characterization effort. Included are copies of the differential scanning calorimetry (DSC) and thermogravimetric analyses (TGA) scans as requested. Also included is a copy of any immediate notification documentation, chain of custody forms, the hot cell work plan, extruded segment [auger] description sheets, and total alpha data.

5291 (WHC-SD-WM-DP–077) **45-Day safety screening for Tank 241-B-102 auger samples, riser 1.** Bell, K.E. Westinghouse Hanford Co., Richland, WA (United States). 1 Dec 1994. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004371. Source: OSTI; NTIS; INIS; GPO Dep.

This is the 45-Day report for the fiscal year 1994 Tank 241-B-102 auger sampling characterization effort. Only one of the two planned auger samples was received by the 222-S Laboratory, however it was decided to begin the 45-day clock and issue a report based on receipt of the first auger sample. Included are copies of the differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA) scans as requested. Also included is a copy of any immediate notification documentation, chain of custody forms, the hot cell work plan, extruded segment [auger] description sheets, and total alpha data. The TGA percent moisture results are below the safety criteria limit of 17% in a subsample taken approximately five minutes after extrusion and a second subsample taken from the lower half of the auger. Verbal and written notifications were made as prescribed. The DSC analysis of all subsamples indicates the presence of fraction exotherms, however the results are a factor of two or more below the notification limit of 523 Joules/gram (J/g). Total alpha results are all below the detection limit. In some cases, the tank characterization plan (TCP) accuracy and precision criteria are not met. If a re-run was not performed when a TCP quality control limit was not met, then reasons for not performing the re-run are provided.

5292 (WHC-SD-WM-ER–368) **Tank characterization report for single-shell Tank 241-B-110.** Amato, L.C. (Los Alamos Technical Associates, Inc., Kennewick, WA (United States)); De Lorenzo, D.S.; DiCenso, A.T.; Rutherford, J.H.; Stephens, R.H.; Heasler, P.G.; Brown, T.M.; Simpson, B.C. Westinghouse Hanford Co., Richland, WA (United States); Los Alamos Technical Associates, Kennewick, WA (United States). Aug 1994. 145p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001164. Source: OSTI; NTIS; INIS; GPO Dep.

Single-shell Tank 241-B-110 is an underground storage tank containing radioactive waste. The tank was sampled at various times between August and November of 1989 and later in April of 1990. The analytical data gathered from these sampling efforts were used to generate this Tank Characterization Report. Tank 241-B-110, located in the 200 East Area B Tank Farm, was constructed in 1943 and 1944, and went into service in 1945 by receiving second cycle decontamination waste from the B and T Plants. During the service life of the tank, other wastes were added including B Plant flush waste, B Plant fission product waste, B Plant ion exchange waste, PUREX Plant coating waste, and waste from Tank 241-B-105. The tank currently contains 246,000 gallons of non-complexed waste, existing primarily as sludge. Approximately 22,000 gallons of drainable interstitial liquid and 1,000 gallons of supernate remain. The solid phase of the waste is heterogeneous, for the top layer and subsequent layers have significantly different chemical compositions and are visually distinct. A complete analysis of the top layer has not been done, and auger sampling of the top layer is recommended to fully characterize the waste in Tank 241-B-110. The tank is not classified as a Watch List tank; however, it is a Confirmed Leaker, having lost nearly 10,000 gallons of waste. The waste in Tank 241-B-110 is primarily precipitated salts, some of which are composed of radioactive isotopes. The most prevalent analytes include water, bismuth, iron, nitrate, nitrite, phosphate, silicon, sodium, and sulfate. The major radionuclide constituents are ^{137}Cs and ^{90}Sr.

5293 (WHC-SD-WM-ER–369) **Tank characterization report for single-shell Tank 241-T-105.** DiCenso, A.T. (Los Alamos Technical Associates, Kennewick, WA (United States)); Amato, L.C.; Franklin, J.D.; Nuttall, G.L.; Johnson, K.W.; Simpson, B.C. Westinghouse Hanford Co., Richland, WA (United States); Los Alamos Technical Associates, Kennewick, WA (United States). Sep 1994. 108p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001405. Source: OSTI; NTIS; INIS; GPO Dep.

Single-Shell Tank 241-T-105, an underground storage tank containing radioactive waste, was most recently sampled in March and May of 1993. Sampling and characterization of the waste in Tank 241-T-105 contribute toward the fulfillment of Milestone M-44-05 of the Hanford Federal Facility Agreement and Consent Order. Tank 241-T-105, located in the 200 West Area T Tank Farm, was constructed in 1944 and went into service in July of 1946 by receiving second cycle decontamination waste from the T Plant. During the service life of the tank, other wastes were added including T Plant first cycle waste, PUREX Plant coating waste, laboratory waste, decontamination waste from T Plant, B Plant low level waste, and B Plant ion exchange waste. The tank currently contains 98,000 gal of non-complexed waste, existing primarily as sludge. Approximately 23,000 gal of drainable interstitial liquid remain. The waste is heterogeneous. Tank 241-T-105 is classified as a non-Watch List tank, with no Unreviewed Safety Questions associated with it at this time. The tank was Interim Stabilized in 1987 and Intrusion Prevention was completed in 1988. The waste in Tank 241-T-105 is comprised of precipitated salts, some of which contain traces of radioactive isotopes. The most prevalent analytes include aluminum, iron, silicon, manganese, sodium, uranium, nitrate, nitrite, and sulfate. The water digested sample results demonstrated that cadmium, chromium, lead, mercury, selenium, and silver concentrations were greater than their Toxicity Characteristic regulatory thresholds. The major radionuclide constituents are ^{90}Sr and ^{137}Cs. The waste is 74.1% solids by weight.

5294 (WHC-SD-WM-ER–379) **An assessment of the potential for a steam bump in Hanford Waste Tank 241-C-106.** Bander, T.J.; Crea, B. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Sep 1994. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95002092. Source: OSTI; NTIS; INIS; GPO Dep.

This document is a preliminary assessment of the potential for a "steam bump" in Tank 241-C-106. The assessment is based on currently available data from significant transients which occurred in Tank C-106. Recommendations are made for additional data needs to clarify the current behavior of this tank. General criteria are provided for making decisions on removing or returning to work restrictions on Tank Farm operations. Also provided are additional actions which should be taken on C-106 to manage tank heat removal.

5295 (WHC-SD-WM-ER–381) **Engineering evaluation of intrusion prevention strategies for single-shell tanks.** Jenkins, C.E. Westinghouse Hanford Co., Richland, WA (United States). 28 Sep 1994. 111p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001406. Source: OSTI; NTIS; INIS; GPO Dep.

In this study, previously implemented actions to prevent liquid intrusion into out-of-service single-shell tanks (SSTs), i.e., interim isolation or partial interim isolation, are investigated and expanded to identify additional cost-effective intrusion prevention techniques that could be reasonably taken until SSTs are ready for waste retrieval. Possible precipitation, groundwater, and condensation pathways and internal tank connections that could provide possible pathways for liquids are examined. Techniques to block identified potential pathways are developed and costed to determine the potential benefit to costed trade-offs for implementing the techniques. (Note: Surveillance data show increased waste surface levels for several SSTs that indicate possible liquid intrusion despite interim isolation activities.)

5296 (WHC-SD-WM-ER–386) **Effect of atmospheric humidity on CPAC optical moisture prediction models - interim report.** Veltkamp, D. Westinghouse Hanford Co., Richland, WA (United States). 28 Sep 1994. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003274. Source: OSTI; NTIS; INIS; GPO Dep.

The tank head space water vapor will be a strong interference of the NIR system as a non-contact camera sensor. The impact of water vapor can be compensated for by explicitly including the water vapor spectral response in the NIR spectra used to generate the PLS (partial least squares) calibration model. PLS models constructed with NIR spectra where water vapor absorption was included as an interferant (from a LOWTRAN computer atmospheric absorption model) predicted moisture from NIR spectra with RMSE (root mean square error) fit errors in the range of 0.729-0.743 wt% moisture. This error correlates well with tank needs and earlier prediction test data where the water vapor was ignored. The models worked equally well with or without the water vapor interferant present in the sensed NIR spectra. Water vapor can also be compensated for if the humidity of the tank head space is measured and the path length between NIR system and waste surface is measured. A simulation using water vapor data from a LOWTRAN atmospheric model, showed wt% moisture values. The conclusion is that water vapor is a strong interferant in waste applications of NIR moisture sensing, however, it can be compensated for with only a small impact on the sensing models and their prediction accuracy.

5297 (WHC-SD-WM-ES–310) **Tank waste concentration mechanism study.** Pan, L.C.; Johnson, L.J. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003067. Source: OSTI; NTIS; INIS; GPO Dep.

This study determines whether the existing 242-A Evaporator should continue to be used to concentrate the Hanford Site radioactive liquid tank wastes or be replaced by an alternative waste concentration process. Using the same philosophy, the study also determines what the waste concentration mechanism should be for the future TWRS program. Excess water from liquid DST waste should be removed to reduce the volume of waste feed for pretreatment, immobilization, and to free up storage capacity in existing tanks to support interim stabilization of SSTS, terminal cleanout of excess facilities, and other site remediation activities.

5298 (WHC-SD-WM-ETP–118) **Engineering task plan for Tanks 241-AN-103, 104, 105 color video camera systems.** Kohlman, E.H. Westinghouse Hanford Co., Richland, WA (United States). 17 Nov 1994. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004149. Source: OSTI; NTIS; INIS; GPO Dep.

This Engineering Task Plan (ETP) describes the design, fabrication, assembly, and installation of the video camera systems into the vapor space within tanks 241-AN-103, 104, and 105. The one camera remotely operated color video systems will be used to observe and record the activities within the vapor space. Activities may include but are not limited to core sampling, auger activities, crust layer examination, monitoring of equipment installation/removal, and any other activities. The objective of this task is to provide a single camera system in each of the tanks for the Flammable Gas Tank Safety Program.

5299 (WHC-SD-WM-ETP–128) **FY 95 engineering work plan for the design reconstitution implementation action plan.** Bigbee, J.D. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003771. Source: OSTI; NTIS; INIS; GPO Dep.

Design reconstitution work is to be performed as part of an overall effort to upgrade Configuration Management (CM) at TWRS. WHC policy is to implement a program that is compliant with DOE-STD-1073-93, Guide for Operational Configuration Management Program. DOE-STD-1073 requires an adjunct program for reconstituting design information. WHC-SD-WM-CM-009, Design Reconstitution Program Plan for Waste Tank Farms and 242-A Evaporator of Tank Waste Remediation System, is the TWRS plan for meeting DOE-STD-1073 design reconstitution requirements. The design reconstitution plan is complex requiring significant time and effort for implementation. In order to control costs, and integrate the work into other TWRS activities, a Design Reconstitution Implementation Action Plan (DR IAP) will be developed, and approved by those organizations having ownership or functional interest in this activity.

5300 (WHC-SD-WM-ETP–129) **FY 95 engineering work plan to develop grading criteria for configuration management and design reconstitution.** Bigbee, J.D. Westinghouse Hanford Co., Richland, WA (United States). 8 Nov 1994. 5p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003768. Source: OSTI; NTIS; INIS; GPO Dep.

This is an engineering work plan to develop grading criteria for configuration management and design reconstitution.

5301 (WHC-SD-WM-IP–007) **B Plant complex treatment, storage, and disposal units inspection plan.** Beam, T.G. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003281. Source: OSTI; NTIS; INIS; GPO Dep.

Owners or operators of facilities that treat, store, and/or dispose of dangerous waste and/or mixed waste as defined by WAC 173-303, "Dangerous Waste Regulations," must inspect their facilities to prevent malfunctions and deteriorations, operator errors, and discharges that may cause or lead to the release of hazardous waste constituents to the environment and/or cause a threat to human health. The WAC regulations require a written inspection schedule be developed, implemented, and kept at the facility.

5302 (WHC-SD-WM-OTP–161) **Acceptance/operational test procedure 103-SY tank camera purge control system.** Castleberry, J.L. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004422. Source: OSTI; NTIS; INIS; GPO Dep.

This Acceptance/Operational Test Procedure will document the satisfactory operation of the 103-SY Camera Purge Control System.

5303 (WHC-SD-WM-OTP–163) **Operability test procedure for 211BA flow proportional sampler.** Weissenfels, R.D. Westinghouse Hanford Co., Richland, WA (United States). 21 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003996. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this operability test procedure (OTP) is to verify the 211-BA flow proportional sampler system and components function correctly as intended by design. System test will include the sampling system, all associated instrumentation, and Facility Process Monitor and Control System (FPMCS). The combined chemical sewer stream from B Plant flows through sump 211BA-SMP-01 located in 211-BA and is continuously monitored for gamma and beta radiation and pH. 211-BA has been upgraded to include a flow proportional sampler. A specified sample volume will be withdrawn at programmed intervals from the 211BA sump and deposited in a 19 liter plastic carboy. The sampler will be programmed per the vendor installation and operations manual by B Plant instrument maintenance personnel. Samples will be taken during five consecutive sample cycles with the sample volumes and sample frequencies recorded for comparison purposes. Additional tests related to the sampler include the alarm circuitry for loss of power and failure to obtain sample.

5304 (WHC-SD-WM-OTP–165) **Acceptance/operational test procedure 241-AN-107 Video Camera System.** Pedersen, L.T. Westinghouse Hanford Co., Richland, WA (United States). 18 Nov 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003997. Source: OSTI; NTIS; INIS; GPO Dep.

This procedure will document the satisfactory operation of the 241-AN-107 Video Camera System. The camera assembly, including camera mast, pan-and-tilt unit, camera, and lights, will be installed in Tank 241-AN-107 to monitor activities during the Caustic Addition Project. The camera focus, zoom, and iris remote controls will be functionally tested. The resolution and color rendition of the camera will be verified using standard reference charts. The pan-and-tilt unit will be tested for required ranges of motion, and the camera lights will be functionally tested. The master control station equipment, including the monitor, VCRs, printer, character generator, and video micrometer will be set up and performance tested in accordance with original equipment manufacturer's specifications. The accuracy of the video micrometer to measure objects in the range of 0.25 inches to 67 inches will be verified. The gas drying distribution system will be tested to ensure that a drying gas can be flowed over the camera and lens in the event that condensation forms on these components. This test will be performed by attaching the gas input connector, located in the upper junction box, to a pressurized gas supply and verifying that the check valve, located in the camera housing, opens to exhaust the compressed gas. The 241-AN-107 camera system will also be tested to assure acceptable resolution of the camera imaging components utilizing the camera system lights.

5305 (WHC-SD-WM-OTR–163) **Operability test report for 211BA flow proportional sampler.** Weissenfels, R.D. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004499. Source: OSTI; NTIS; INIS; GPO Dep.

This operability report will verify that the 211-BA flow proportional sampler functions as intended by design. The sampler was installed by Project W-007H and is part of BAT/AKART for the BCE liquid effluent stream.

5306 (WHC-SD-WM-PICD–001) **Liquid effluent services and solid waste disposal interface control document.** Carlson, A.B. Westinghouse Hanford Co., Richland, WA (United States). 27 Oct 1994. 122p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003271. Source: OSTI; NTIS; INIS; GPO Dep.

This interface control document between Liquid Effluent Services (LES) and Solid Waste Disposal (SWD) establishes the functional responsibilities of each division where interfaces exist between the two divisions. The document includes waste volumes and timing for use in planning the proper waste management capabilities. The interface control document also facilitates integration of existing or planned waste management capabilities of the Liquid Effluent Services and Solid Waste divisions.

5307 (WHC-SD-WM-PLN–081-Rev.3) **Mixer pump long term operations plan for Tank 241-SY-101 mitigation.** Irwin, J.J. Westinghouse Hanford Co., Richland, WA (United States). 7 Sep 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003867. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the general Operations Plan for performance of the mixer pump long term operations for Tank 241-SY-101 mitigation of gas retention and periodic release in Tank 101-SY. This operations plan will utilize a 112 kW (150 hp) mixing pump to agitate/suspend the particulates in the tank.

5308 (WHC-SD-WM-PROC–009-Rev.1) **B Plant Complex generator dangerous waste storage areas inspection plan: Revision 1.** Beam, T.G. Westinghouse Hanford Co., Richland, WA (United States). 3 Nov 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003841. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains the inspection plan for the <90 day dangerous/mixed waste storage areas and satellite accumulation areas at B Plant Complex. This inspection plan is designed to comply with all applicable federal, state and US Department of Energy-Richland Operations Office training requirements. In particular, the requirements of WAC 173-303 "Dangerous Waste Regulations" are met by this inspection plan. This inspection plan is designed to provide B Plant Complex with the records and documentation showing that the waste storage and handling program is in compliance with applicable regulations. The plan also includes the requirements for becoming a qualified inspector of waste storage areas and the responsibilities of various individuals and groups at B Plant Complex.

5309 (WHC-SD-WM-PSE–010) **Preliminary safety evaluation for 241-C-106 waste retrieval, project W-320.** Conner, J.C. Westinghouse Hanford Co., Richland, WA (United States). 18 Oct 1994. 153p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003277. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the Preliminary Safety Evaluation for Project W-320, Tank 241-C-106 Waste Retrieval Sluicing System (WRSS). The US DOE has been mandated to develop plans for response to safety issues associated with the waste storage tanks

at the Hanford Site, and to report the progress of implementing those plans to Congress. The objectives of Project W-230 are to design, fabricate, develop, test, and operate a new retrieval system capable of removing a minimum of about 75% of the high-heat waste contained in C-106. It is anticipated that sluicing operations can remove enough waste to reduce the remaining radiogenic heat load to levels low enough to resolve the high-heat safety issue as well as allow closure of the tank safety issue.

5310 (WHC-SD-WM-QAPP-009-Rev.1) **242-A evaporator quality assurance project plan: Revision 1.** Tucker, B.J. Westinghouse Hanford Co., Richland, WA (United States). 4 Nov 1994. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003843. Source: OSTI; NTIS; INIS; GPO Dep.

The scope of this quality assurance project plan (Plan) is sampling and analytical services including, but not limited to, sample receipt, handling and storage, analytical measurements, submittal of data deliverables, archiving selected portions of samples, returning unneeded sample material to Westinghouse Hanford Company (WHC), and/or sample disposal associated with candidate feed samples and process condensate compliance samples. Sampling and shipping activities are also included within the scope. The purpose of this project is to provide planning, implementation, and assessment guidance for achieving established data quality objectives measurement parameters. This Plan requires onsite and offsite laboratories to conform to that guidance. Laboratory conformance will help ensure that quality data are being generated and therefore, that the 242-A evaporator is operating in a safe and compliant manner. The 242-A evaporator feed stream originates from double-shell tanks (DSTs) identified as candidate feed tanks. The 242-A evaporator reduces the volume of aqueous waste contained in DSTs by boiling off water and sending it to the Liquid Effluent Retention Facility (LERF) storage basin before further treatment. The slurry product is returned to DSTs. Evaporation results in considerable savings by reducing the volume of mixed waste for disposal.

5311 (WHC-SD-WM-RD-049) **System requirements specification for waste information and control system.** Harris, R.R. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 133p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004153. Source: OSTI; NTIS; INIS; GPO Dep.

This document defines the requirements for the Waste Information and Control System (WICS). The document defines the functions, constraints, and objectives that pertain to WICS. This shall serve as the baseline document to ensure the needs of the Hazardous Material Control group (HMC) at 222-S Laboratory are met with regard to assurance of accuracy and quality of data taken with WICS.

5312 (WHC-SD-WM-RPT-099) **Compliance matrix for the mixed waste disposal facilities, Trenches 31 & 34, burial ground 218-W-5.** Carlyle, D.W. Westinghouse Hanford Co., Richland, WA (United States). 31 Oct 1994. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004500. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the Trench 31 & 34 Mixed Waste Disposal Facility Compliance Matrix is to provide objective evidence of implementation of all regulatory and procedural-institutional requirements for the disposal facilities. This matrix provides a listing of the individual regulatory and procedural-institutional requirements that were addressed. Subject matter experts reviewed pertinent documents that had direct or indirect impact on the facility. Those found to be applicable were so noted and listed in Appendix A. Subject matter experts then extracted individual requirements from the documents deemed applicable and listed them in the matrix tables. The results of this effort are documented in Appendix B.

5313 (WHC-SD-WM-SDD-027) **207-A retention basins system design description.** Wahlquist, R.A. Westinghouse Hanford Co., Richland, WA (United States). 29 Sep 1994. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95002087. Source: OSTI; NTIS; INIS; GPO Dep.

The 242-A Evaporator is a waste treatment facility designed to reduce liquid waste volumes currently stored in the Hanford Area double shell Waste Storage Tanks. The evaporator uses evaporative concentration to achieve this volume reduction, returning the concentrated slurry to the double-shell tanks for storage. The process effluent is transferred to various retention/treatment facilities for eventual release to the environment. The process utilizes an evaporator vessel and various supporting systems for heating, evaporating, and condensing low-heat-generating liquid waste produced it the Hanford Site. The process reduces the total volume of the liquid waste requiring storage in a double shell tank, making it more manageable for current storage as well as for future treatment and disposal. The main components of the 242-A Evaporator are the Reboiler, Vapor-Liquid Separator, Recirculation Pump and Pump Loop, Slurry System, Condenser System, Steam Jet Vacuum System, Condensate Collection Tank, and Ion Exchange System.

5314 (WHC-SD-WM-SDP-011) **FY95 software project management plan: TMACS, CASS computer systems.** Spurling, D.G. Westinghouse Hanford Co., Richland, WA (United States). 11 Nov 1994. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004486. Source: OSTI; NTIS; INIS; GPO Dep.

The FY95 Work Plan for TMACS and CASS Software Projects describes the activities planned for the current fiscal year. This plan replaces WHC-SD-WM-SDP-008. The TMACS project schedule is included in the TWRS Integrated Schedule.

5315 (WHC-SD-WM-SSP-005) **Grout Facilities standby plan.** Claghorn, R.D.; Kison, P.F.; Nunamaker, D.R.; Yoakum, A.K. Westinghouse Hanford Co., Richland, WA (United States). 29 Sep 1994. 299p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001521. Source: OSTI; NTIS; INIS; GPO Dep.

This plan defines how the Grout Facilities will be deactivated to meet the intent of the recently renegotiated Tri-Party Agreement (TPA). The TPA calls for the use of the grout process as an emergency option only in the event that tank space is not available to resolve tank safety issues. The availability of new tanks is expected by 1997. Since a grout startup effort would take an estimated two years, a complete termination of the Grout Disposal Program is expected in December 1995. The former Tank Waste Remediation (TWRS) Strategy, adopted in 1988, called for the contents of Hanford's 28 newer double-shell waste tanks to be separated into high-level radioactive material to be vitrified and disposed of in a geologic repository; low-level wastes were to be sent to the Grout Facility to be made into a cement-like-mixture and poured into underground vaults at Hanford for disposal. The waste in the 149 older single-shell tanks (SST) were to undergo further study and analysis before a disposal decision was made.

5316 (WHC-SD-WM-TC-066) **Test procedure – Prototype core sampler.** Linschooten, C.G. Westinghouse Hanford Co., Richland, WA (United States). 1 Nov 1994. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003845. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this test is to attempt to determine the adequacy of the prototype sampler. Recovery tests will be performed with this sampler in three different consistencies of kaolin sludge simulants. A minimum of six tests will be done in each of the simulants. The sampler is a hollow steel sampling tube with a tapered nose and a retractable point. The point is sealed against the inside wall of the sampler by two O-rings, which keep the waste material from entering the sampler prematurely. When the point is retracted, the biggest O-ring assists in collecting the sample by producing a slight negative pressure within the sampler tube. The sampler can be operated by hand. The concept is similar to, but simpler than, the present WHC rotary valve sampler in that a solid core is recovered and an O-ring piston is used to provide a negative internal pressure to assist sample recovery. The test will be performed in three 55-gallon drums each filled with a kaolin sludge of a different consistency. The drums will contain an approximate depth of 33 inches of sludge. The prototype Concord sampler will attempt to collect 19-inch samples at two distinct depths. No waste tank simulation with full length or any length of the auger shroud equipment

will be attempted in this test. A simple locating and clamping tool will be made to facilitate the sampling.

5317 (WHC-SD-WM-TI-540-Rev.1) **Analysis report for 241-BY-104 Auger samples.** Beck, M.A. Westinghouse Hanford Co., Richland, WA (United States). 10 Nov 1994. 907p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004432. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the analysis of the surface crust samples taken from single-shell tank (SST) BY-104, suspected of containing ferrocyanide wastes. This sampling and analysis will assist in ascertaining whether there is any hazard due to combustion (burning) or explosion of these solid wastes. These characteristics are important to future efforts to characterize the salt and sludge in this type of waste tank. This report will outline the methodology and detail the results of analyses performed during the characterization of this material. All analyses were performed by Westinghouse Hanford Company at the 222-S laboratory unless stated otherwise.

5318 (WHC-SD-WM-TI-577-Rev.1) **Preliminary flowsheet for plasma arc calcination of selected Hanford tank waste.** Hendrickson, D.W. Westinghouse Hanford Co., Richland, WA (United States). 19 Sep 1994. 108p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003270. Source: OSTI; NTIS; INIS; GPO Dep.

This preliminary flowsheet document was developed for the Initial Pretreatment Module (IPM). This flowsheet documents the calcination technology that can be used to accomplish the destruction of organics, ferrocyanide, and nitrate/nitrite salts in addition to solubilizing aluminum compounds in selected waste tanks at the Hanford Site. The flow sheet conditions are 76 L/min diluted waste feed rate at 800°C, atmospheric pressure, and 100 millisecond residence time in the calciner. Preliminary flow diagrams, material balances, and energy requirements are presented.

5319 (WHC-SD-WM-TI-633) **Structural analysis and evaluation of the 241SY101 tank annulus heat-up.** Ziada, H.H. Westinghouse Hanford Co., Richland, WA (United States). 19 Oct 1994. 264p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003161. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the structural analysis (static and thermal loads) of the 241SY101 tank to determine the maximum allowable temperature and rate of heating that could be applied to tank 241SY101 through annulus air heating without detrimental effects to the structural integrity of the concrete and steel liner of the tank.

5320 (WHC-SD-WM-TI-634-Rev.1) **Integrated beta and gamma radiation dose calculations for the ferrocyanide waste tanks.** Parra, S.A. Westinghouse Hanford Co., Richland, WA (United States). 30 Nov 1994. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004496. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains the total integrated beta and gamma radiation doses in all the ferrocyanide waste tanks. It also contains estimated gamma radiation dose rates for all single-shell waste tanks containing a liquid observation well.

5321 (WHC-SD-WM-TI-652) **Statistical characterization report for single-shell Tank 241-S-104.** Cromar, R.D.; Wilmarth, S.R.; Jensen, L. Westinghouse Hanford Co., Richland, WA (United States). 27 Sep 1994. 57p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001409. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains the results of the statistical analysis of data from three core samples obtained from single-shell Tank 241-S-104 (S-104). Section 2.0 contains a description of the core samples and the chemical analyses performed on the core samples. Section 3.0 contains mean concentration estimates and associated 95% confidence intervals (CIs) on the mean for each of the analytes found in the core samples. Section 4.0 contains estimates of the spatial variability (variability between cores) and estimates of the analytical variability from the core composite data. Two types of analytical variability were estimated from the core composite data: (1) sample composite variability (variability between composite samples within the same core) and (2) analytical measurement variability (variability between the primary and duplicate analyses within each core composite sample). Estimates of the analytical measurement variability were used as the reference value to test the significance of the spatial and sample composite variability. Spatial variability was significantly different from zero for 22 out of 63 analytes. The sample composite variance was significantly different from zero for 20 out of the 63 analytes.

5322 (WHC-SD-WM-TP-193) **Non-destructive examination of grouted waste.** Benny, H.L. Westinghouse Hanford Co., Richland, WA (United States). 18 Nov 1994. 89p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004150. Source: OSTI; NTIS; INIS; GPO Dep.

This data report contains the results of ultrasonic pulse velocity (UPV) and unconfined compressive strength (USC) measurements on a grouted simulant of 106AN tank waste. This testing program was conducted according to the requirements detailed in WHC-1993a. If successful, these methods could lead to a system for the remote verification of waste form quality. The objectives of this testing program were: to determine if a relationship exists between the velocity of ultrasonic compression waves and the unconfined compressive strength of simulated grouted waste, and if so, determine if the relationship is a valid method for grout quality assessment; and to determine if a relationship exists between the attenuation of wave amplitude and the age of test specimens. The first objective was met, in that a relationship between the UPV waves and USC was determined. This method appears to provide a valid measure of the quality of the grouted waste, as discussed in Sections 3.0 and 4.0. The second objective, to determine if the attenuation of UPV waves was related to the age of test specimens was partially met. A relationship does exist between wave amplitude and age, but it is doubtful that this method alone can be used to verify the overall quality of grouted waste. Section 2.0 describes the test methods, with the results detailed in Section 3.0. A discussion of the results are provided in Section 4.0.

5323 (WHC-SD-WM-TP-229) **Tank 241-AW-101 tank characterization plan.** Sathyanarayana, P. Westinghouse Hanford Co., Richland, WA (United States). 22 Nov 1994. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004000. Source: OSTI; NTIS; INIS; GPO Dep.

The first section gives a summary of the available information for Tank AW-101. Included in the discussion are the process history and recent sampling events for the tank, as well as general information about the tank such as its age and the risers to be used for sampling. Tank 241-AW-101 is one of the 25 tanks on the Flammable Gas Watch List. To resolve the Flammable Gas safety issue, characterization of the tanks, including intrusive tank sampling, must be performed. Prior to sampling, however, the potential for the following scenarios must be evaluated: the potential for ignition of flammable gases such as hydrogen-air and/or hydrogen-nitrous oxide; and the potential for secondary ignition of organic-nitrate/nitrate mixtures in crust layer initiated by the burning of flammable gases or by a mechanical in-tank energy source. The characterization effort applicable to this Tank Characterization Plan is focused on the resolution of the crust burn flammable gas safety issue of Tank AW-101. To evaluate the potential for a crust burn of the waste material, calorimetry tests will be performed on the waste. Differential Scanning Calorimetry (DSC) will be used to determine whether an exothermic reaction exists.

5324 (WHC-SD-WM-TP-231) **Tank 241-BY-103 tank characterization plan.** Carpenter, B.C. Westinghouse Hanford Co., Richland, WA (United States). 21 Oct 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003275. Source: OSTI; NTIS; INIS; GPO Dep.

This document is a plan which serves as the contractual agreement between the Characterization Program, Sampling Operations, WHC 222-S Laboratory, Oak Ridge National Laboratory, and PNL 329 Laboratory. The scope of this plan is to provide guidance for the sampling and analysis of vapor samples from tank 241-BY-103.

5325 (WHC-SD-WM-TP–259) **Tank 241-C-105 tank characterization plan.** Schreiber, R.D. (Westinghouse Savannah River Co., Aiken, SC (United States)). Westinghouse Hanford Co., Richland, WA (United States); Los Alamos Technical Associates, Kennewick, WA (United States). 28 Oct 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003062. Source: OSTI; NTIS; INIS; GPO Dep.

This document is a plan which serves as the contractual agreement between the Characterization Program, Sampling Operations, WHC 222-S Laboratory, and PNL 325 Analytical Chemistry Laboratory. The scope of this plan is to provide guidance for the sampling and analysis of samples from tank 241-C-105.

5326 (WHC-SD-WM-TP–265) **Test plan for Enraf Series 854 level gauge testing in Tank 241-S-106.** Barnes, G.A. Westinghouse Hanford Co., Richland, WA (United States). 23 Aug 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94018508. Source: OSTI; NTIS; INIS; GPO Dep.

An Enraf Series 854 level gauge was installed on Tank 241-S-106 (S-106) during the first week of June 1994. On August 11, 1994, the gauge's measuring wire broke. An investigation has been started to determine how the wire broke. This test plan identifies a qualification test that is part of this investigation. This test will also provide evidence as to the location and extent of potential corrosion on the measuring wire due to tank environment. The results from this testing will provide data for better material selections. This test will involve placing the existing Enraf Series 854 level gauge back into service with the same type of measuring wire (316 stainless steel) that originally broke on August 11, 1994. The gauge will be operated for 14 days. At the end of the 14-day test, the wire shall be sent to Pacific Northwest Laboratory (PNL) for analysis.

5327 (WHC-SD-WM-TP–277) **Tank 241-AP-106 tank characterization plan.** Valenzuela, B.D. Westinghouse Hanford Co., Richland, WA (United States). 7 Nov 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003769. Source: OSTI; NTIS; INIS; GPO Dep.

This document is a plan which serves as the contractual agreement between the Characterization Program, Sampling Operations, WHC 222-S Laboratory, and PNL 325 Analytical Chemistry Laboratory. The scope of this plan is to provide guidance for the sampling and analysis of samples from tank 241-AP-106.

5328 (WHC-SD-WM-TP–277-Rev.1) **Tank 241-AP-106 tank characterization plan: Revision 1.** Valenzuela, B.D. Westinghouse Hanford Co., Richland, WA (United States). 17 Nov 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003848. Source: OSTI; NTIS; INIS; GPO Dep.

Tank 241-AP-106 (AP-106) is a candidate feed tank which is expected to be processed at the 242-A Evaporator. Three issues related to the overall concern of the evaporator must be evaluated: compatibility of the candidate waste with respect to feed tank, slurry tank, and evaporator requirements; safety parameters of the candidate waste tank to avoid a facility condition which is outside the safety boundaries; and compliance of the waste as dictated by regulations from various government and environmental agencies. The characterization efforts of this Tank Characterization Plan are focused on the resolution of the issues above. To evaluate the potential for waste incompatibility with the feed tank, slurry tank, and evaporator, as well as relevant safety issues, analyses will be performed on the grab samples obtained from tank AP-106. These analyses are discussed in Section 4.0. Once the characterization of tank AP-106 has been performed, the waste compatibility and safety assessment shall be conducted. This effort is discussed elsewhere.

5329 (WHC-SD-WM-TP–280) **Tank 241-BY-111 tank characterization plan.** Homi, C.S. Westinghouse Hanford Co., Richland, WA (United States). 3 Nov 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003842. Source: OSTI; NTIS; INIS; GPO Dep.

The sampling and analytical needs associated with the 51 Hanford Site underground storage tanks classified on one or more of the four Watch Lists (ferrocyanide, organic, flammable gas, and high heat), and the safety screening of all 177 tanks have been identified through the Data Quality Objective (DQO) process. DQO's identify information needed by a program group in the Tank Waste Remediation System concerned with safety issues, regulatory requirements, or the transporting and processing of tank waste. This Tank Characterization Plan will identify characterization objectives for Tank BY-111 pertaining to sample collection, sample preparation and analysis, and laboratory analytical evaluation and reporting requirements. In addition, an estimate of the current contents and status of the tank is given.

5330 (WHC-SD-WM-TRP–197) **Foam insulated transfer line test report.** Squier, D.M. Westinghouse Hanford Co., Richland, WA (United States). Jun 1994. 220p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003854. Source: OSTI; NTIS; INIS; GPO Dep.

Miles of underground insulated piping will be installed at the Hanford site to transfer liquid waste. Significant cost savings may be realized by using pre-fabricated polyurethane foam insulated piping. Measurements were made on sections of insulated pipe to determine the insulation's resistance to axial expansion of the pipe, the force required to compress the foam in the leg of an expansion loop and the time required for heat up and cool down of a buried piping loop. These measurements demonstrated that the peak axial force increases with the amount of adhesion between the encasement pipe and the insulation. The compressive strength of the foam is too great to accommodate the thermal growth of long straight pipe sections into the expansion loops. Mathematical models of the piping system's thermal behavior can be refined by data from the heated piping loop.

5331 (WHC-SD-WM-TRP–208) **RGA-5 process gas analyzer test report.** Weamer, J.L. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003773. Source: OSTI; NTIS; INIS; GPO Dep.

The gas monitoring system, GMS-2, includes two gas monitors. GC-2 measures high hydrogen concentrations (0.2–10%) and GC-3 measures the lower concentration levels (10–100 ppm). Although redundant instruments are in place for accurately measuring the higher hydrogen concentrations, there are no redundant instruments to accurately measure the relatively low baseline hydrogen concentrations. The RGA-5 process gas analyzer is a two-column GC that will replace GC-2 and provide redundancy for GC-3. This upgrade will provide faster response time and reduce tank farm entries for routine operations because the RGA-5 is remotely operable. Tests were conducted according to WHC-SD-WM-TP-262, RGA-5 Process Gas Analyzer Test Plan. The first objective was to verify that the vendor-supplied RGA host data acquisition software allowed communication between the RGA-5 and an ISA bus personal computer. The second objective was to determine the capabilities of the RGA-5 process gas analyzer. The tests did the following: with a constant flow rate and pressure, determined the concentration range that each column can accurately and precisely measure; identified any uncorrected interferences from other tank gases such as ammonia, nitrous oxide, or methane; and determined the response and decay time.

5332 (WHC-SD-WM-TRP–218) **Application of infrared imaging in ferrocyanide tanks.** Morris, K.L.; Mailhot, R.B. Jr.; McLaren, J.M.; Morris, K.L. Westinghouse Hanford Co., Richland, WA (United States). 28 Sep 1994. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001574. Source: OSTI; NTIS; INIS; GPO Dep.

This report analyzes the feasibility of using infrared imaging techniques and scanning equipment to detect potential hot spots within ferrocyanide waste tanks at the Hanford Site. A hot spot is defined as a volumetric region within a waste tank with an excessively warm temperature that is generated by radioactive isotopes. The thermal image of a hot spot was modeled by computer. this model determined the image an IR system must detect. Laboratory and field tests of the imaging system are described, and conclusions

based on laboratory and field data are presented. The report shows that infrared imaging is capable of detecting hot spots in ferrocyanide waste tanks with depths of up to 3.94 m (155 in.). The infrared imaging system is a useful technology for initial evaluation and assessment of hot spots in the majority of ferrocyanide waste tanks at the Hanford Site. The system will not allow an exact hot spot and temperature determination, but it will provide the necessary information to determine the worst-case hot spot detected in temperature patterns. Ferrocyanide tanks are one type of storage tank on the Watch List. These tanks are identified as priority 1 Hanford Site Tank farm Safety Issues.

5333 (WHC-SD-WM-WP–291) **Work plan for new SY tank farm exhauster, on-site fabrication activities.** McClees, J. Westinghouse Hanford Co., Richland, WA (United States). 22 Nov 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004101. Source: OSTI; NTIS; INIS; GPO Dep.

The replacement SY tank farm exhauster unit is a new piece of equipment, designed to replace the existing SY tank farm K1 Ventilation System exhauster unit. This work plan describes the shop fabrication activities associated with the receiving, assembly, repair, modification, and testing of the new SY tank farm primary exhauster. A general list of these activities include, but are not limited to: repair all shipping damages, including procurement of replacement parts; fabricate hardware needed to install exhauster in the field (e.g., Vent duct tie-in, duct concrete footings/hangers, stack concrete footings, etc.); incorporate equipment modification as provided by WHC Engineering (e.g., Rewire the Alarm Annunciator Cabinet as fail-safe, connections between the exhauster and stack sample cabinet, etc.); test the entire exhauster unit, to the extent possible, prior to field installation; and prepare exhauster unit for transfer to and installation at SY tank farm.

5334 (WSRC-MS–94-0149) **Characterization of Type 304L stainless steel solid-state closure welds for radioactive waste containment.** West, S.L. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940793–2: 27. annual International Metallographic Society meeting, Montreal (Canada), 24-27 Jul 1994). Order Number DE94016539. Source: OSTI; NTIS; INIS; GPO Dep.

Radioactive wastes, generated during years of nuclear materials production, will be vitrified in glass and sealed in canisters. These cylindrical canisters are fabricated from 0.375 inches (9.5 mm) thick Type 304L stainless steel plate and are 24 inches (61 cm) in diameter and 118 inches (3 m) tall with a forged nozzle. The canisters will be sealed by resistance upset welding a 5 inch (12.7 cm) diameter, 0.5 inch (1.27 cm) thick, slightly oversized plug into the nozzle. A parametric study recommended a range of production welding variables based on mechanical tests and metallography. Intentionally "cold" welds produced with low currents and short times exhibited insufficient interface length and lack-of-bonding. At very high currents, long weld times and low force, maximum heating occurred with significant melting at the top, which makes process stability a concern. All welds made between these extremes exhibited predominantly solid-state bonding. Little variation in microstructure between welds was found along much of the interface with changes in current, force and time. Hardness traverses across the welds showed higher values at the interface, indicative of the worked microstructure. Crevices formed at the top and bottom during plastic flow of the material, and grain sizes varied along the interface from differences in dynamic recrystallization and grain growth. The degree of melting at the top was the most significant difference among welds made within the recommended parameter range.

5335 (WSRC-MS–94-0211) **Specialized video systems for use in underground storage tanks.** Heckendorn, F.M. (Westinghouse Savannah River Co., Aiken, SC (United States)); Robinson, C.W.; Anderson, E.K.; Pardini, A.F. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950232–1: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE94019063. Source: OSTI; NTIS; INIS; GPO Dep.

The Robotics Development Groups at the Savannah River Site and the Hanford site have developed remote video and photography systems for deployment in underground radioactive waste storage tanks at Department of Energy (DOE) sites as a part of the Office of Technology Development (OTD) program within DOE. Figure 1 shows the remote video/photography systems in a typical underground storage tank environment. Viewing and documenting the tank interiors and their associated annular spaces is an extremely valuable tool in characterizing their condition and contents and in controlling their remediation. Several specialized video/photography systems and robotic End Effectors have been fabricated that provide remote viewing and lighting. All are remotely deployable into and from the tank, and all viewing functions are remotely operated. Positioning all control components away from the facility prevents the potential for personnel exposure to radiation and contamination. Overview video systems, both monaural and stereo versions, include a camera, zoom lens, camera positioner, vertical deployment system, and positional feedback. Each independent video package can be inserted through a 100 mm (4 in.) diameter opening. A special attribute of these packages is their design to never get larger than the entry hole during operation and to be fully retrievable. The End Effector systems will be deployed on the large robotic Light Duty Utility Arm (LDUA) being developed by other portions of the OTD-DOE programs. The systems implement a multi-functional "over the coax" design that uses a single coaxial cable for all data and control signals over the more than 900 foot cable (or fiber optic) link.

5336 (WSRC-MS–94-0214P) **A simple model of the batch electrochemical reduction of nitrate/nitrite waste.** Wingard, D.A. (South Carolina Univ., Columbia, SC (United States). Dept. of Chemical Engineering); Weidner, J.W.; Van Zee, J.W.; Hobbs, D.T. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-940529–23: 185. Electrochemical Society meeting, San Francisco, CA (United States), 22-27 May 1994). Order Number DE94016693. Source: OSTI; NTIS; INIS; GPO Dep.

A model of a divided parallel plate electrochemical cell operated in a batch mode for the destruction of NO_3^-/NO_2^- in alkaline waste streams is presented. The model uses boundary layer approximations at each electrode and at the separator to minimize computation time. Five competing electrochemical reactions are included at the cathode. The model uses either an explicit Runge-Kutta routine with empirically determined current efficiencies or an implicit stepping routine for each electrode if the current efficiencies are to be predicted. Tim dependent changes of the concentration, temperature, and cell voltage are predicted for constant current operation. Model predictions are compared with experimental data.

5337 (WSRC-MS–94-0246-Rev.1) **SPEEDUP simulation of liquid waste batch processing. Revision 1.** Shannahan, K.L. (and others); Aull, J.E.; Dimenna, R.A. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 44p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9411135–1-Rev.1: ASPENWORLD 94, Boston, MA (United States), 6-9 Nov 1994). Order Number DE95001240. Source: OSTI; NTIS; INIS; GPO Dep.

The Savannah River Site (SRS) has accumulated radioactive hazardous waste for over 40 years during the time SRS made nuclear materials for the United States Department of Energy (DOE) and its predecessors. This waste is being stored as caustic slurry in a large number of 1 million gallon steel tanks, some of which were initially constructed in the early 1950's. SRS and DOE intend to clean up the Site and convert this waste into stable forms which then can be safely stored. The liquid waste will be separated into a partially decontaminated low-level and radioactive high-level waste in one feed preparation operation, In-Tank Precipitation. The low-level waste will be used to make a concrete product called saltstone in the Saltstone Facility, a part of the Defense Waste Processing Facility (DWPF). The concrete will be poured into large vaults, where it will be permanently stored. The high-level waste will be added to glass-formers and waste slurry solids from another

feed preparation operation, Extended Sludge Processing. The mixture will then be converted to a stable borosilicate glass by a vitrification process that is the other major part of the DWPF. This glass will be poured into stainless steel canisters and sent to a temporary storage facility prior to delivery to a permanent underground storage site.

5338 (WSRC-MS–94-0320) **Regulations, criticality, and long-term storage of HE-SNF.** Apperson, C.E.; Mincey, J.F. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–6: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95001247. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy is exploring various options to determine how to best handle research and defense reactor spent fuel if it is not reprocessed. One option being considered is direct disposal. A number of regulations governing direct disposal have been issued. The technology to construct a repository to these regulations is being developed in parallel with the design. Issues identified in preliminary studies have given rise to four challenging questions relative to criticality safety in a mined geologic repository. A path for resolving these questions is presented.

5339 (WSRC-MS–94-0444) **Repository emplacement costs for Al-clad high enriched uranium spent fuel.** McDonell, W.R.; Parks, P.B. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–2: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95000748. Source: OSTI; NTIS; INIS; GPO Dep.

A range of strategies for treatment and packaging of Al-clad high-enriched uranium (HEU) spent fuels to prevent or delay the onset of criticality in a geologic repository was evaluated in terms of the number of canisters produced and associated repository costs incurred. The results indicated that strategies in which neutron poisons were added to consolidated forms of the U-Al alloy fuel generally produced the lowest number of canisters and associated repository costs. Chemical processing whereby the HEU was removed from the waste form was also a low cost option. The repository costs generally increased for isotopic dilution strategies, because of the substantial depleted uranium added. Chemical dissolution strategies without HEU removal were also penalized because of the inert constituents in the final waste glass form. Avoiding repository criticality by limiting the fissile mass content of each canister incurred the highest repository costs.

5340 (WSRC-MS–94-0446) **Life-cycle cost analysis for Foreign Research Reactor, Spent Nuclear Fuel disposal.** Parks, P.B.; Geddes, R.L.; Jackson, W.N.; McDonell, W.R.; Dupont, M.E.; McWhorter, D.L.; Liutkus, A.S. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–4: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95000749. Source: OSTI; NTIS; INIS; GPO Dep.

DOE-EM-37 requested a life-cycle cost analysis for disposal of the Foreign Research Reactor-Spent Nuclear Fuel (FRR-SNF). The analysis was to address life-cycle and unit costs for a range of FRR-SNF elements from those currently available (6,000 elements) to the (then) bounding case (15,000 elements). Five alternative disposition strategies were devised for the FRR-SNF elements. Life-cycle costs were computed for each strategy. In addition, the five strategies were evaluated in terms of six societal and technical goals. This report summarizes the study that was originally documented to DOE-EM.

5341 (WSRC-MS–94-0467) **The impacts of prolonged wet storage of DOE reactor irradiated nuclear materials at the Savannah River Site.** Burke, S.D.; Howell, J.P. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–1: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95000527. Source: OSTI; NTIS; INIS; GPO Dep.

Over 2700 metric tons of reactor irradiated nuclear material (FJNM) is stored throughout the Department of Energy (DOE) weapons complex. Of that, 95% is stored in water basins. Approximately 200 metric tons are stored in water basins at the Savannah River Site (SRS) near Aiken, SC. The conditions of the RINM stored at the SRS represent the fall range of conditions of fuel throughout the complex. The RINM stored in the SRS reactor disassembly basins has undergone severe corrosion and necessitated mitigative actions, whereas that stored in the Receiving Basin for Offsite Fuels (RBOF) has suffered none. This paper reports the conditions of the corroding RINM inventory at the SRS and the subsequent mitigative actions that are being taken as a result.

5342 (WSRC-MS–94-0558) **Savannah River Site inventories and storage issues.** Allender, J.S.; Krupa, J.F. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–15: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95003212. Source: OSTI; NTIS; INIS; GPO Dep.

The Savannah River Site (SRS) holds more than 200 metric tons of heavy metal in fuels and targets that have been irradiated in defense-production and research reactors. Most of the bulk of this material was derived from production operations at the Site, and is clad with aluminum. Savannah River stores a smaller amount of irradiated items from research reactors, including more than 50 unique configurations and compositions. Based on a "Regionalization" option that would transfer aluminum-clad fuels to SRS, capital costs for a long-term dry-storage facility could range up to $1.7 billion (FY-1994 dollars) if facilities are provided for all current and future aluminum fuels. The cost could be reduced to $1.2 billion if current aluminum fuels and targets are processed instead of packaged for long-term storage, and to $0.8 bllion if most of the future receipts of foreign and domestic research fuels were also processed.

5343 (WSRC-MS–94-0564) **Experiments for evaluation of corrosion to develop storage criteria for interim dry storage of aluminum-alloy clad spent nuclear fuel.** Peacock, H.B.; Sindelar, R.L.; Lam, P.S.; Murphy, T.H. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941207–12: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95002691. Source: OSTI; NTIS; INIS; GPO Dep.

The technical bases for specification of limits to environmental exposure conditions to avoid excessive degradation are being developed for storage criteria for dry storage of highly-enriched, aluminum-clad spent nuclear fuels owned by the US Department of Energy. Corrosion of the aluminum cladding is a limiting degradation mechanism (occurs at lowest temperature) for aluminum exposed to an environment containing water vapor. Attendant radiation fields of the fuels can lead to production of nitric acid in the presence of air and water vapor and would exacerbate the corrosion of aluminum by lowering the pH of the water solution. Laboratory-scale specimens are being exposed to various conditions inside an autoclave facility to measure the corrosion of the fuel matrix and cladding materials through weight change measurements and metallurgical analysis. In addition, electrochemical corrosion tests are being performed to supplement the autoclave testing by measuring differences in the general corrosion and pitting corrosion behavior of the aluminum cladding alloys and the aluminum-uranium fuel materials in water solutions.

5344 (WSRC-MS–94-0569) **Vitrification of hazardous and radioactive wastes.** Bickford, D.F.; Schumacher, R. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-9411154–1: Fall meeting of the American Ceramic Society, Columbus, OH (United States), 14-18 Nov 1994). Order Number DE95003460. Source: OSTI; NTIS; INIS; GPO Dep.

Vitrification offers many attractive waste stabilization options. Versatility of waste compositions, as well as the inherent durability of a glass waste form, have made vitrification the treatment of choice for high-level radioactive wastes. Adapting the technology to other hazardous and radioactive waste streams will provide an environmentally acceptable solution to many of the waste challenges that face the public today. This document reviews various types and technologies involved in vitrification.

5345 (WSRC-MS–94-0582) **Practical guidelines for small-volume additions of uninhibited water to waste storage tanks.** Hsu, T.C.; Wiersma, B.J.; Zapp, P.E.; Pike, J.A. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950393–1: NACE international annual corrosion conference, Orlando, FL (United States), 26-28 Mar 1995). Order Number DE95004345. Source: OSTI; NTIS; INIS; GPO Dep.

Allowable volumes of uninhibited water additions to waste tanks are limited to volumes in which hydroxide and nitrite inhibitors reach required concentrations by diffusion from the bulk waste within five days. This diffusion process was modeled conservatively by Fick's second law of diffusion. The solution to the model was applied to all applicable conditions which exist in the waste tanks. Plant engineers adapted and incorporated the results into a practical working procedure for controlling and monitoring the addition of uninhibited water. Research, technical support, and field engineers worked together to produce an effective solution to a potential waste tank corrosion problem.

5346 (WSRC-RP–92-349) **Two items: Transcription of a presentation by Dr. E. L. Albenesius, "SRS burial ground operation from an historical perspective"; video tape entitled "Burial ground operation".** Holcomb, H.P. Westinghouse Savannah River Co., Aiken, SC (United States). 14 Feb 1992. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95001217. Source: OSTI; NTIS; INIS; GPO Dep.

On February 6, 1992, approximately 35 SRS personnel from DOE, WSRC, and Dames and Moore attended a very informative talk given by Dr. E.L. Albenesius who discussed the operation of the SRS Burial Ground from an historical perspective. Dr. Albenesius, a Du Point retiree, formerly served as research manager of SRL's Environmental Effects and Solid Waste Management Technology Divisions among other assignments. One notable point Dr. Albenesius made was in answer to a question concerning what was the most important thing that could be done to reduce the hazard to man from buried waste. His response was to remove as much plutonium as practical prior to closure. In order to preserve this valuable information for the record, the program was audiotaped from which a point-by-point chronological transcription, with minor editing, was prepared.

5347 (WSRC-RP–94-00780) **Los Alamos National Laboratory simulated sludge vitrification demonstration.** Cicero, C.A. (Westinghouse Savannah River Co., Aiken, SC (United States)); Bickford, D.F.; Bennert, D.M.; Overcamp, T.J. Westinghouse Savannah River Co., Aiken, SC (United States). 30 Sep 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95004344. Source: OSTI; NTIS; INIS; GPO Dep.

Technologies are being developed to convert hazardous and mixed wastes to a form suitable for permanent disposal. Vitrification, which has been declared the Best Demonstrated Available Technology (BDAT) for high-level radioactive waste disposal by the EPA, is capable of producing a highly durable wasteform that minimizes disposal volumes through organic destruction, moisture evaporation, and porosity reduction. However, this technology must be demonstrated over a range of waste characteristics, including compositions, chemistries, moistures, and physical characteristics to ensure that it is suitable for hazardous and mixed waste treatment. This project plans to demonstrate vitrification of simulated wastes that are considered representatives of wastes found throughout the DOE complex. For the most part, the primary constituent of the wastes is flocculation aids, such as $Fe(OH)_3$, and natural filter aids, such as diatomaceous earth and perlite. The filter aids consist mostly of silica, which serves as an excellent glass former; hence, the reason why vitrification is such a viable option. LANL is currently operating a liquid waste processing plant which produces an inorganic sludge similar to other waste water treatment streams. Since this waste has characteristics that make it suitable for vitrification and the likelihood of success is high, it shall be tested at CU. The objective of this task is to characterize the process behavior and glass product formed upon vitrification of simulated LANL sludge. The off-gases generated from the production runs will also be characterized to help further develop vitrification processes for mixed and low level wastes.

5348 (WSRC-TR–92-0403) **Integrated DWPF Melter System (IDMS) campaign report: Hanford Waste Vitrification Plan (HWVP) process demonstration.** Hutson, N.D. Westinghouse Savannah River Co., Aiken, SC (United States). 10 Aug 1992. 405p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003485. Source: OSTI; NTIS; INIS; GPO Dep.

Vitrification facilities are being developed worldwide to convert high-level nuclear waste to a durable glass form for permanent disposal. Facilities in the United States include the Department of Energy's Defense Waste Processing Facility (DWPF) at the Savannah River Site, the Hanford Waste Vitrification Plant (HWVP) at the Hanford Site and the West Valley Demonstration Project (WVDP) at West Valley, NY. At each of these sites, highly radioactive defense waste will be vitrified to a stable borosilicate glass. The DWPF and WVDP are near physical completion while the HWVP is in the design phase. The Integrated DWPF Melter System (IDMS) is a vitrification test facility at the Savannah River Technology Center (SRTC). It was designed and constructed to provide an engineering-scale representation of the DWPF melter and its associated feed preparation and off-gas treatment systems. Because of the similarities of the DWPF and HWVP processes, the IDMS facility has also been used to characterize the processing behavior of a reference NCAW simulant. The demonstration was undertaken specifically to determine material balances, to characterize the evolution of offgas products (especially hydrogen), to determine the effects of noble metals, and to obtain general HWVP design data. The campaign was conducted from November, 1991 to February, 1992.

5349 (WSRC-TR–94-015) **Metallurgical Laboratory Hazardous Waste Management Facility groundwater monitoring report. Fourth quarter 1993 and 1993 summary.** Westinghouse Savannah River Co., Aiken, SC (United States). Mar 1994. 258p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE94012943. Source: OSTI; NTIS; GPO Dep.

The AMB wells at the Metallurgical Laboratory Hazardous Waste Management Facility (Met Lab HWMF) are monitored for selected constituents to comply with the Natural Resources Defense council et al. Consent Decree of May 1988 that identifies the Met Lab HWMF as subject to the Resource Conservation and Recovery Act. In addition, the wells are monitored, as requested, for other constituents as part of the Savannah River Site (SRS) Groundwater Monitoring Program. During the fourth quarter 1993, samples from AMB groundwater monitoring wells at the Metallurgical Laboratory Hazardous Waste Management Facility were analyzed for selected heavy metals, indicator parameters, radionuclides, volatile organic compounds, and other constituents. Six parameters exceeded standards during the quarter. As in previous quarters, dichloromethane (methylene chloride), tetrachloroethylene, and trichloroethylene exceeded final Primary Drinking Water Standards; pH, specific conductance, and total organic halogens exceeded the Savannah River Site Flag 2 criteria in one or more of the wells. Groundwater flow direction and rate in the water-table unit were similar to previous quarters.

5350 (WSRC-TR–94-0297-Rev.1) **Characterization of hazardous constituents in HLW supernate and implications for solid LLW generation.** Georgeton, G.K. Westinghouse Hanford Co., Richland, WA (United States). 10 Oct 1994. 29p. Sponsored

by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003462. Source: OSTI; NTIS; INIS; GPO Dep.

High Level Waste (HLW) generated during Separations processing in the F- and H-Canyons is transferred to the Tank Farms for stage in 51 underground, million gallon storage tanks. The waste is an aqueous solution containing dissolved sodium salts and insoluble metal oxides/hydroxides. The waste solution is evaporated to reduce the volume, and the resulting saltcake and residual supernate are stored. Over the 40 year history of the Tank Farm, routine supernate sampling has been conducted in support of the primary goal of safe storage of HLW. As a result of routine and non-routine activities that are part of managing these highly radioactive wastes, secondary solid waste is generated. Radioactive contamination of over 90% of the solid waste generated is due to contact with BLW supernate or saltcake. In order to comply with the Waste Acceptance Criteria (WAC) for of solid waste in the E-Area Vaults (EAV), the quantity of certain radioisotopes must be manifested for each waste container and a declaration made of whether or not the waste is hazardous. However, solid waste is not amenable to routine analysis, this forces a reliance on analytical data from supernate samples to characterize the contamination. To provide the manifest information, process knowledge in combination with the limited amount of analytical data will be used. This report documents the characterization of hazardous components in the HLW supernate associated with the waste storage, evaporation and sludge processing facilities. The hazardous constituents of HLW are identified and the fate of the constituents is tracked based on knowledge of each phase of the process. The limited amount of sample data that includes analyses for hazardous species is then used to establish average and maximum characterization values. Finally, a screening based on an average supernate is compared to the criteria for the individual streams to evaluate the amount of conservatism introduced for the individual streams.

5351 (WSRC-TR–94-0389) **Evaluation of sludge screening limit for Tank Farm Low Level Waste.** Georgeton, G.K. Westinghouse Savannah River Co., Aiken, SC (United States). 11 Aug 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95002821. Source: OSTI; NTIS; INIS; GPO Dep.

High Level Waste (HLW) generated during Separations processing in the F- and H-Canyons is transferred to the 241-F/H Tank Farms for storage in 61 underground, carbon steel tanks. The waste is an aqueous solution containing dissolved sodium salts and insoluble metal oxides/hydroxides. As the waste is collected in a receipt tank, the insoluble solids settle to form the sludge phase. The supernatant solution is decanted to an evaporator to reduce the volume. The evaporator concentrate is transferred to another waste tank and is cooled, causing the sodium salts to precipitate from solution and form the saltcake phase. Eventually, the soluble and insoluble components will be separately prepared for processing within the DWPF for final disposal. As a result of routine and non-routine activities that are part of managing these highly radioactive wastes, secondary solid waste is generated. Low level waste (LLW) such as protective clothing, plastic sheeting, plastic huts, etc. are connected for disposal in B-25, B-12 and other waste containers. The wastes are transferred to the E-Area Vaults (EAV) for disposal, and must comply with the Waste Acceptance Criteria (WAC) for disposal of LLW. Compliance with the WAC includes manifesting the quantities of certain radioisotopes and declaring that the waste containers are not hazardous. However, solid waste is not amenable to routine smearing and analysis to determine the required information. This report documents the evaluation to ensure that LLW contaminated with sludge at 10,000 dpm/100 cm^2 of alpha emitters is nonhazardous. The hazardous constituent present in the greatest ratio to its Resource Conservation and Recovery Act (RCRA) limit is identified, and the concentration of that component in the leachate from a TCLP test is calculated. Finally, implications of this evaluation on screening LLW in the field are identified.

5352 (WSRC-TR–94-0467) **Evaluation of concentrations of hazardous components to support removal of the Tank 48 thermowell.** Georgeton, G.K. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003461. Source: OSTI; NTIS; INIS; GPO Dep.

In support of start-up activities for the In Tank Precipitation (ITP) process, a thermowell is scheduled to be removed from Tank 48. Disposal of the thermowell in the Solid Waste Disposal Facility (SWDF) requires manifesting the quantities of several radioisotopes and, equally important, declaring that the waste package is nonhazardous. Sampling of the waste in the package (i.e., the thermowell) to determine quantities of hazardous materials or to perform a Toxicity Characteristic Leaching Procedure (TCLP) is not prudent or practical. Extremely high dose rates due to contamination of the thermowell preclude any close contact to obtain smear samples, and obtaining a representative sample of the various parts of the thermowell for a TCLP is not feasible. Alternatively, the TCLP can be simulated using a limited amount of data supplemented with process knowledge. This information can be further developed into a conservative screening tool to provide guidance on declaring whether the waste package is hazardous or not. This report documents the information and calculations of hazardous component concentrations used to support the possible disposal of the Tank 48 thermowell.

5353 (WSRC-TR–94-0520) **Receipt and processing of RBOF/RRF liquid waste in H-Tank Farm.** Marra, J.E. Westinghouse Savannah River Co., Aiken, SC (United States). 31 Oct 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003894. Source: OSTI; NTIS; INIS; GPO Dep.

The Receiving Basin for Off-Site Fuels/Resin Regeneration Facility (RBOF/RRF) currently generates approximately 50,000 gallons of wastewater per month. This waste is sent to the 211-H General Purpose (GP) evaporator and/or the 241-H Tank Farm (HTF). The primary criteria for selecting the destination of the waste are solids content and radioactively.The waste is typically sent to the GP evaporator if it has low solids content and low activity. Currently, approximately 70% of the waste water produced at RBOF/RRF meets the criteria for acceptance by the GP evaporator. In June 1993, High Level Waste Engineering opened a Technical Issue (TI) related to processing of RBOF/RRF directly through the 1H Cesium Removal Column (CRC) to the F/H Effluent Treatment Facility (ETF). In March 1994, additional emphasis was placed on this effort after it was determined that the 1H evaporator had a failed tube bundle. As a result, The TI was expanded to include evaluations of methods to increase the acceptance rate of wastewater at the GP (i.e., to ensure that the 70% of RBOF/RRF wastewater that currently meets the GP acceptance criteria is actually processed at the GP). Since March 1994, waste receipts from RBOF/RRF have averaged less than the 30,000 gallons/month allotted in the HLW System Plan. In addition, the RBOF/RRF waste sent to HTF has successfully been processed through the 2H evaporator. Based on this progress, no additional effort should be expended to reduce the amount of RBOF/RRF sent to HTF, either by increasing the criteria for acceptance of RBOF/RRF waste at the GP evaporator or by evaluating alternate treatment options (such as processing through the 1H CRC or installing treatment equipment in the RBOF/RRF).

0530 Environmental Aspects

Refer also to citation(s) 5133, 5138, 5139, 5140, 5141, 5142, 5151, 5158, 5159, 5176, 5177, 5181, 5189, 5190, 5221, 5222, 5352, 5384, 5394, 5408, 5421, 5824, 5825, 7016

5354 (DOE/AL/62350–64-Rev.1) **Baseline risk assessment of ground water contamination at the uranium mill tailings site near Falls City, Texas: Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 161p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003889. Source: OSTI; NTIS; INIS; GPO Dep.

This baseline risk assessment of ground water contamination of the uranium mill tailings site near Falls City, Texas, evaluates potential impact to public health and the environment resulting from ground water contamination at the former Susquehanna Western, Inc. (SWI), uranium mill processing site. This document fulfills the

following objectives: determine if the site presents immediate or potential future health risks, determine the need for interim institutional controls, serve as a key input to project planning and prioritization, and recommend future data collection efforts to more fully characterize risk. The Uranium Mill Tailings Remedial Action (UMTRA) Project has begun its evaluation of ground water contamination at the Falls City site. This risk assessment is one of the first documents specific to this site for the Ground Water Project. The first step is to evaluate ground water data collected from monitor wells at or near the site. Evaluation of these data show the main contaminants in the Dilworth ground water are cadmium, cobalt, fluoride, iron, nickel, sulfate, and uranium. The data also show high levels of arsenic and manganese occur naturally in some areas.

5355 (DOE/AL/62350–134) **Baseline risk assessment of ground water contamination at the uranium mill tailings site Salt Lake City, Utah.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 159p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003911. Source: OSTI; NTIS; INIS; GPO Dep.

This baseline risk assessment of groundwater contamination at the uranium mill tailings site near Salt Lake City, Utah, evaluates potential public health or environmental impacts resulting from ground water contamination at the former uranium ore processing site. The tailings and other contaminated material at this site were placed in a disposal cell located at Clive, Utah, in 1987 by the US Department of Energy's Uranium Mill Tailings Remedial Action (UMTRA) Project. The second phase of the UMTRA Project is to evaluate residual ground water contamination at the former uranium processing site, known as the Vitro processing site. This risk assessment is the first site-specific document under the Ground Water Project. It will help determine the appropriate remedial action for contaminated ground water at the site.

5356 (DOE/AL/62350–147) **Baseline risk assessment of ground water contamination at the uranium mill tailings sites near Slick Rock, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 238p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003882. Source: OSTI; NTIS; INIS; GPO Dep.

This baseline risk assessment of ground water contamination at the uranium mill tailings sites near Slick Rock, Colorado, evaluates potential public health and environmental impacts resulting from ground water contamination at the former North Continent (NC) and Union Carbide (UC) uranium mill processing sites. The tailings at these sites will be placed in a disposal cell at the proposed Burro Canyon, Colorado, site. The US Department of Energy (DOE) anticipates the start of the first phase remedial action by the spring of 1995 under the direction of the DOE's Uranium Mill Tailings Remedial Action (UMTRA) Project. The second phase of the UMTRA Project will evaluate ground water contamination. This baseline risk assessment is the first site-specific document for these sites under the Ground Water Project. It will help determine the compliance strategy for contaminated ground water at the site. In addition, surface water and sediment are qualitatively evaluated in this report.

5357 (DOE/AL/62350–149) **Baseline risk assessment of ground water contamination at the uranium mill tailings site near Canonsburg, Pennsylvania.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 131p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003890. Source: OSTI; NTIS; INIS; GPO Dep.

This baseline risk assessment evaluates potential impacts to public health and the environment resulting from ground water contamination from past activities at the former uranium processing site in Canonsburg, Pennsylvania. The US Department of Energy Uranium Mill Tailings Remedial Action (UMTRA) Project has placed contaminated material from this site in an on-site disposal cell. Currently, the UMTRA Project is evaluating ground water contamination. This risk assessment is the first document specific to this site for the UMTRA Ground Water Project. Currently, no domestic or drinking water well tap into contaminated ground water of the two distinct ground water units: the unconsolidated materials and the bedrock. Because there is no access, no current health or environmental risks are associated with the direct use of the contaminated ground water. However, humans and ecological organisms could be exposed to contaminated ground water if a domestic well were to be installed in the unconsolidated materials in that part of the site being considered for public use (Area C). The first step is evaluating ground water data collected from monitor wells at the site. For the Canonsburg site, this evaluation showed the contaminants in ground water exceeding background in the unconsolidated materials in Area C are ammonia, boron, calcium, manganese, molybdenum, potassium, strontium, and uranium.

5358 (DOE/AL/62350–150) **Baseline risk assessment of ground water contamination at the inactive uraniferous lignite ashing site near Bowman, North Dakota.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 159p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003885. Source: OSTI; NTIS; INIS; GPO Dep.

This baseline risk assessment of ground water contamination at the inactive uraniferous lignite ashing site near Bowman, North Dakota, evaluates the potential impacts to public health or the environment from contaminated ground water at this site. This contamination is a result of the uraniferous lignite ashing process, when coal containing uranium was burned to produce uranium. Potential risk is quantified only for constituents introduced by the processing activities and not for the constituents naturally occurring in background ground water in the site vicinity. Background ground water, separate from any site-related contamination, imposes a percentage of the overall risk from ground water ingestion in the Bowman site vicinity. The US Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project is developing plans to address soil and ground water contamination at the site. The UMTRA Surface Project involves the determination of the extent of soil contamination and design of an engineered disposal cell for long-term storage of contaminated materials. The UMTRA Ground Water Project evaluates ground water contamination. Based on results from future site monitoring activities as defined in the site observational work plan and results from this risk assessment, the DOE will propose an approach for managing contaminated ground water at the Bowman site.

5359 (DOE/OR/21443–T2) **An Assessment of health risk associated with mercury in soil and sediment from East Fork Poplar Creek, Oak Ridge, Tennessee. Final report.** Revis, N.; Holdsworth, G.; Bingham, G.; King, A.; Elmore, J. Oak Ridge Research Inst., TN (United States). Apr 1989. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21443. Order Number DE94011971. Source: OSTI; NTIS; GPO Dep.

This report presents results from a study conducted to determine the toxicity of Mercury in soils sediments samples. Mice were fed via diet, soils and sediment, from various locations along the East Fork Poplar creek. Tissue distribution of pollutants was determined at various intervals. The tissue level relative to toxicity was used to determine the effect of a complex matrix on the gastrointestinal absorption and tissue distribution of the pollutants (other pollutants included cadmium and selenium).

5360 (DOE/RL–89-12-Rev.2-Draft-A) **Hanford site ground water protection management plan.** Department of Energy, Richland, WA (United States). Richland Operations Office. Oct 1994. 72p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003266. Source: OSTI; NTIS; INIS; GPO Dep.

Ground water protection at the Hanford Site consists of preventative and remedial measures that are implemented in compliance with a variety of environmental regulations at local, state, and federal levels. These measures seek to ensure that the resource can sustain a broad range of beneficial uses. To effectively coordinate and ensure compliance with applicable regulations, the U.S. Department of Energy has issued DOE Order 5400.1 (DOE 1988a). This order requires all U.S. Department of Energy facilities to prepare separate ground water protection program descriptions and plans. This document describes the Ground Water Protection Management Plan (GPMP) for the Hanford Site located in the state of Washington. DOE Order 5400.1 specifies that the GPMP covers

the following general topical areas: (1) documentation of the ground water regime; (2) design and implementation of a ground water monitoring program to support resource management and comply with applicable laws and regulations; (3) a management program for ground water protection and remediation; (4) a summary and identification of areas that may be contaminated with hazardous waste; (5) strategies for controlling hazardous waste sources; (6) a remedial action program; and (7) decontamination, decommissioning, and related remedial action requirements. Many of the above elements are currently covered by existing programs at the Hanford Site; thus, one of the primary purposes of this document is to provide a framework for coordination of existing ground water protection activities. The GPMP provides the ground water protection policy and strategies for ground water protection/management at the Hanford Site, as well as an implementation plan to improve coordination of site ground water activities.

5361 (LA–12861-MS) **A compendium of results from long-range alpha detector soil surface monitoring: June 1992–May 1994.** Garner, S.E. (Los Alamos National Lab., NM (United States)); Bounds, J.A.; Allander, K.S.; Johnson, J.D.; MacArthur, D.W.; Caress, R.W. Los Alamos National Lab., NM (United States). Nov 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95004230. Source: OSTI; NTIS; INIS; GPO Dep.

Soil surface monitors based on long-range alpha detector (LRAD) technology are being used to monitor alpha contamination at various sites in the Department of Energy complex. These monitors, the large soil-surface monitor (LSSM) and the small soil-surface monitor (SSSM), were used to help characterize sites at Fernald, Ohio, and active or inactive firing sites at Sandia National Laboratories and Los Alamos National Laboratory. Monitoring results are presented herein in chronological order.

5362 (LA–12872-MS) **Tritium concentrations in bees and honey at Los Alamos National Laboratory.** Fresquez, P.R.; Armstrong, D.R.; Salazar, J.G. Los Alamos National Lab., NM (United States). Dec 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95004388. Source: OSTI; NTIS; INIS; GPO Dep.

Los Alamos National Laboratory (LANL) has maintained a network of honey bee colonies at LANL, perimeter (Los Alamos townsite and White Rock/Pajarito Acres) and regional (background) areas for over 15 years; the main objective of this honey bee network was to help determine the bioavailability of certain radionuclides in the environment. Of all the radionuclides studied (^{3}H, ^{57}Co, ^{7}Be, ^{22}Na, ^{54}Mn, ^{83}Rb, ^{137}Cs, ^{238}Pu, ^{239}Pu, ^{90}Sr and total U), tritium was consistently detected in bees and was most readily transferred to the honey. In fact, honey collected from hives located at TA-21, TA-33, TA-50, TA-53, and TA-54 and from White Rock/Pajarito Acres contained significantly higher concentrations of ^{3}H than regional background hives. Based on the average concentration of all radionuclides measured over the years, the effective dose equivalent (EDE) from consuming 5 kg (11 lb) of honey collected from Los Alamos (townsite) and White Rock/Pajarito Acres, after regional background has been subtracted, was 0.0186 ($\pm$0.0507) and 0.0016 ($\pm$0.0010) mrem/yr, respectively. The highest EDE, based on the mean + 2SD (95% confidence level), was 0.1200 mrem/y; this was <0.2% of the International Commission on Radiological Protection permissible dose limit of 100 mrem/yr from all pathways.

5363 (ORNL–6728) **An aerial survey of radioactivity associated with Atomic Energy plants.** Davis, F.J.; Harlan, W.E.; Humphrey, P.A.; Kane, R.L.; Reinhardt, P.W. Oak Ridge National Lab., TN (United States). 2 Sep 1992. 165p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (ORNL–341-Del.). Order Number DE95004718. Source: OSTI; NTIS; GPO Dep.

The project covered was an endeavor to (1) compare a group of laboratory instruments as airborne detectors of radioactivity and (2) simultaneously obtain data relative to the diffusion rate of radioactive contamination emitted into the atmosphere from off-gas stacks of production runs. Research was conducted in the Oak Ridge, Tennessee and Hanford, Washington areas. Detection was accomplished at a maximum distance of seventeen miles from the plant. Very little information of a conclusive nature was gained concerning the diffusion. Further research with the nuclear instruments, using a stronger source, is recommended. To obtain conclusive information concerning the meteorological aspects of the project, a larger observational program will be needed.

5364 (ORNL–6834) **Wetlands Assessment for site characterization, Advanced Neutron Source (ANS).** Wade, M.C. (Oak Ridge National Lab., TN (United States). Energy Div.); Socolof, M.L.; Rosensteel, B.; Awi, D. Oak Ridge National Lab., TN (United States). Oct 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003897. Source: OSTI; NTIS; INIS; GPO Dep.

This Wetlands Assessment has been prepared in accordance with the Department of Energy's (DOE) Code of Federal Regulations (CFR) 10 CFR 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements, which established the policy and procedure for implementing Executive Order 11990, Protection of Wetlands. The proposed action is to conduct characterization activities in or near wetlands at the ANS site. The proposed action will covered under a Categorical Exclusion, therefore this assessment is being prepared as a separate document [10 CFR 1022.12(c)]. The purpose of this Wetlands Assessment is to fulfill the requirements of 10 CFR 1022.12(a) by describing the project, discussing the effects of the proposed action upon the wetlands, and considering alternatives to the proposed action.

5365 (PNL–9995) **Literature review supporting assessment of potential radionuclides in the 291-Z exhaust ventilation.** Mahoney, L.A. (Pacific Northwest Lab., Richland, WA (United States)); Ballinger, M.Y.; Jette, S.J.; Thomas, L.M. Glissmeyer, J.A.; Davis, W.E. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94017779. Source: OSTI; NTIS; INIS; GPO Dep.

This literature review was prepared to support a study conducted by Pacific Northwest Laboratory to assess the potential deposition and resuspension of radionuclides in the 291-Z ventilation exhaust building located in the 200 West Area of the US Department of Energy's Hanford Project near Richland, Washington. The filtered ventilation air from three of the facilities at the Plutonium Finishing Plant (PFP) complex are combined together in the 291-Z building before discharge through a common stack. These three facilities contributing filtered exhaust air to the discharge stream are (1) the PFP, also known as the Z-Plant or 234-5Z, (2) the Plutonium Reclamation Facility (PRF or 236-Z), and (3), the Waste Incinerator Building (WIB or 232-Z). The 291-Z building houses the exhaust fans that pull air from the 291-Z central collection plenum and exhausts the air to the stack. Section 2.0 of this report is a description of the physical characteristic of the ventilation system from the High Efficiency Particulate Air (HEPA) filters to the exhaust stack. A description of the processes performed in the facilities that are vented through 291-Z is given in Section 3.0. The description focuses on the chemical and physical forms of potential aerosols given off from the unit operations. A timeline of the operations and events that may have affected the deposition of material in the ventilation system is shown. Aerosol and radiation measurements taken in previous studies are also discussed. Section 4.0 discusses the factors that influence particle deposition and adhesion. Mechanisms of attachment and resuspension are covered with specific attention to the PFP ducts. Conclusions and recommendations are given in Section 5.0.

5366 (PNL–10196) **Predicted impacts of future water level decline on monitoring wells using a ground-water model of the Hanford Site.** Wurstner, S.K.; Freshley, M.D. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 110p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004987. Source: OSTI; NTIS; INIS; GPO Dep.

A ground-water flow model was used to predict water level decline in selected wells in the operating areas (100, 200, 300, and 400 Areas) and the 600 Area. To predict future water levels, the unconfined aquifer system was stimulated with the two-dimensional version of a ground-water model of the Hanford Site, which is based on the Coupled Fluid, Energy, and Solute Transport

(CFEST) Code in conjunction with the Geographic Information Systems (GIS) software package. The model was developed using the assumption that artificial recharge to the unconfined aquifer system from Site operations was much greater than any natural recharge from precipitation or from the basalt aquifers below. However, artificial recharge is presently decreasing and projected to decrease even more in the future. Wells currently used for monitoring at the Hanford Site are beginning to go dry or are difficult to sample, and as the water table declines over the next 5 to 10 years, a larger number of wells is expected to be impacted. The water levels predicted by the ground-water model were compared with monitoring well completion intervals to determine which wells will become dry in the future. Predictions of wells that will go dry within the next 5 years have less uncertainty than predictions for wells that will become dry within 5 to 10 years. Each prediction is an estimate based on assumed future Hanford Site operating conditions and model assumptions.

5367 (PNL–10281) **Ecological Compliance Assessment Project: 1994 Summary report.** Brandt, C.A. Pacific Northwest Lab., Richland, WA (United States). Nov 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004988. Source: OSTI; NTIS; INIS; GPO Dep.

The Ecological Compliance Assessment Project (ECAP) began full operation on March 1, 1994. The project is designed around a baseline environmental data concept that includes intensive biological field surveys of key areas of the Hanford Site where the majority of Site activities occur. These surveys are conducted at biologically appropriate times of year to ensure that the data gathered are current and accurate. The data are entered into the ECAP database, which serves as a reference for the evaluation of review requests coming in to the project. This methodology provided the basis for over 90 percent of the review requests received. Field surveys conducted under ECAP are performed to document occurrence information for species of concern and to obtain habitat descriptions. There are over 200 species of concern on the Hanford Site, including plants, birds, mammals, reptiles, amphibians, fish, and invertebrates. In addition, Washington State has designated mature sagebrush-steppe habitat as a Priority Habitat meriting special protective measures. Of the projects reviewed, 17 resulted or will result in impacts to species or habitats of concern on the Hanford Site. The greatest impact has been on big sagebrush habitat. Most of the impact has been or will be within the 600 Area of the Site.

5368 (SAND–93-4020) **Bulk and mechanical properties of the Paintbrush tuff recovered from borehole USW NRG-6: Data report.** Martin, R.J. (New England Research, Inc., White River Junction, VT (United States)); Boyd, P.J.; Noel, J.S.; Price, R.H. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 105p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004385. Source: OSTI; NTIS; INIS; GPO Dep.

Experimental results are presented for bulk and mechanical properties measurements on specimens of the Paintbrush tuff recovered from borehole USW NRG-6 at Yucca Mountain, Nevada. Measurements have been performed on four thermal/mechanical units, TCw, PTn, TSw1 and TSw2. On each specimen the following bulk properties have been reported: dry bulk density, saturated bulk density, average grain density, and porosity. Unconfined compression to failure, confined compression to failure, and indirect tensile strength tests were performed on selected specimens recovered from the borehole. In addition, compressional and shear wave velocities were measured on specimens designated for unconfined compression and confined compression experiments. Measurements were conducted at room temperature on nominally water saturated specimens; however, some specimens of PTn were tested in a room dry condition. The nominal strain rate for the fracture experiments was 10^{-5} s $^{-1}$.

5369 (USGS/OFR–94-491) **Meteorological data for four sites at surface-disruption features in Yucca Flat, Nevada Test Site, Nye County, Nevada, 1985–1986.** Carman, R.L. Geological Survey, Carson City, NV (United States). 1994. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AI08-91NV11040. Order Number DE95004391. Source: OSTI; NTIS; INIS; GPO Dep.

Surface-disruption features, or craters, resulting from underground nuclear testing at the Nevada Test Site may increase the potential for ground-water recharge in an area that would normally produce little, if any, recharge. This report presents selected meteorological data resulting from a study of two surface-disruption features during May 1985 through June 1986. The data were collected at four adjacent sites in Yucca Flat, about 56 kilometers north of Mercury, Nevada. Three sites (one in each of two craters and one at an undisturbed site at the original land surface) were instrumented to collect meteorological data for calculating bare-soil evaporation. These data include (1) long-wave radiation, (2) short-wave radiation, (3) net radiation, (4) air temperature, and (5) soil surface temperature. Meteorological data also were collected at a weather station at an undisturbed site near the study craters. Data collected at this site include (1) air temperature, (2) relative humidity, (3) wind velocity, and (4) wind direction.

5370 (WHC-EP–0527-3) **Environmental releases for calendar year 1993.** Thomas, S.P.; Curn, B.L. Westinghouse Hanford Co., Richland, WA (United States). Jul 1994. 102p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001314. Source: OSTI; NTIS; INIS; GPO Dep.

This report presents data on radioactive and nonradioactive materials released into the environment during calendar year 1993 from facilities managed by Westinghouse Hanford Company. As part of this executive summary, comprehensive data summaries of air emissions and liquid effluents in 1993 are displayed in tables. These tables represent the following: radionuclide air emissions data; data on radioactive liquid effluents discharged to the soil; radionuclides discharged to the Columbia River; nonradioactive air emissions data; total volumes and flow rates of 200/600 area liquid effluents. Both summary and detailed presentations of these data are given. When appropriate, comparisons to data from previous years are made.

5371 (WHC-SD-EN-TI–229) **Geophysical survey for proposed borehole 199-K-107A, 100-K Area.** Mitchell, T.H. Westinghouse Hanford Co., Richland, WA (United States). 30 Nov 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004370. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of the survey was to locate subsurface obstructions that may affect the drilling of proposed borehole, 199-K-107A, located about 100 ft northwest of the 105 KW Building, 100-K Area. Based upon the results of the survey, possible drill sites within the zone, with the least likelihood of encountering identified obstructions, were identified. The ground-penetrating radar (GPR) system used for this work utilized a 300-megahertz antenna to transmit the electromagnetic (EM) energy into the ground. The transmitted energy is reflected back to a receiving antenna where variations in the return signal are recorded. Common reflectors include natural geologic conditions such as bedding, cementation, moisture, and clay, or man-made objects such as pipes, barrels, foundations, and buried wires. Several isolated anomalies, at various depths, are observed in the data. Additionally, two areas that appear disturbed, with perplexing character, are plotted. Because of the uncertain nature of these two areas, they were avoided when recommending a borehole location. Initially, the proposed borehole was staked at N130/E122. The new proposed borehole location is N139/E176. This location appears free of anomalies and is over 10 ft from interpreted linear anomalies/pipe-like features.

5372 (WHC-SD-EN-TI–271) **Radionuclide logging of Tank 216-T-106, borehole 299-W10-196.** Price, R.K. Westinghouse Hanford Co., Richland, WA (United States). 4 Nov 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003862. Source: OSTI; NTIS; INIS; GPO Dep.

Geophysical surveys were conducted in borehole 299-W10-196 during construction to profile the radionuclide contaminants in the vadose zone that leaked from single-shell Tank 216-T-106. Contaminants from the tank leak were detected to 120 feet below the

ground surface. A second complete geophysical survey was conducted about one year after drilling was completed to evaluate contaminant movement that may have been caused by the presence of the cased borehole. Contaminant movement would warrant plugging and abandoning the borehole. Comparison of the two surveys indicate that no contamination movement to greater depths can be identified.

5373 (WHC-SD-L045H-SM–001) **300 Area treated effluent disposal facility sampling schedule.** Loll, C.M. Westinghouse Hanford Co., Richland, WA (United States). 11 Oct 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003243. Source: OSTI; NTIS; INIS; GPO Dep.

This document is the interface between the 300 Area Liquid Effluent Process Engineering (LEPE) group and the Waste Sampling and Characterization Facility (WSCF), concerning process control samples. It contains a schedule for process control samples at the 300 Area TEDF which describes the parameters to be measured, the frequency of sampling and analysis, the sampling point, and the purpose for each parameter.

5374 (WHC-SD-WM-EMP–032) **Tritium emissions from 200 East Area Double-Shell Tanks.** Bachand, D.D. Westinghouse Hanford Co., Richland, WA (United States). 28 Nov 1994. 96p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004364. Source: OSTI; NTIS; INIS; GPO Dep.

This document evaluates the need for tritium sampling of the emissions from the 200 East Area Double Shell Tanks based on the requirements of "National Emission Standards for Hazardous Air Pollutants" (NESHAP). The NESHAP requirements are specified in 40 Code of Federal Regulation (CFR), Part 61, Subpart H; "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities".

5375 (WHC-SD-WM-ER–395) **Technical description of Stack 296-B-5.** Ridge, T.M. Westinghouse Hanford Co., Richland, WA (United States). 15 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003766. Source: OSTI; NTIS; INIS; GPO Dep.

Of particular concern to facilities on the Hanford site is Title 40, Code of Federal Regulations, Chapter 40, Part 61, Subpart H, "National emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." Assessments of facility stacks and potential radionuclide emissions determined whether these stacks would be subject to the sampling and monitoring requirements of 40 CFR 61, Subpart H. Stack 296-B-5 exhausts 221-BB building which houses tanks containing B Plant steam condensate and B Plant process condensate from the operation of the low-level waste concentrator. The assessment of potential radionuclide emissions from the 296-B-5 stack resulted in an effective dose equivalent to the maximally exposed individual of less than 0.1 millirem per year. Therefore, the stack is not subject to the sampling and monitoring requirements of 40 CFR 61, Subpart H. However, the sampling and monitoring system must be in compliance with the Environmental Compliance Manual, WHC-CM-7-5. Currently, 296-B-5 is sampled continuously with a record sampler and continuous air monitor (CAM).

5376 (WSRC-IM–93-17-7) **Environmental implementation plan: Chapter 7, Groundwater protection.** Wells, D. (comp.). Westinghouse Savannah River Co., Aiken, SC (United States). 10 Aug 1994. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003907. Source: OSTI; NTIS; INIS; GPO Dep.

The Savannah River Site (SRS) uses large quantities of groundwater for drinking, processing, and non-contact cooling. Continued industrial and residential growth along with additional agricultural irrigation in areas adjacent to SRS will increase the demand for groundwater. This increasing demand will require a comprehensive management system to ensure the needed quality and quantity of groundwater is available for all users. The Groundwater Protection Program and the Waste Management Program establish the overall framework for protecting this resource. Ground water under SRS is monitored extensively for radiological, hazardous, and water quality constituents. Groundwater quality is known to have been affected at 33 onsite locations, but none of the contaminant plumes have migrated offsite. Onsite and offsite drinking water supplies are monitored to ensure they are not impacted. The site has more than 1800 monitoring wells from which groundwater samples are analyzed for radiological and non-radiological constituents. SRS is complying with all applicable regulations related to groundwater protection, waste treatment, and waste disposal. The existing waste storage facilities are permitted or are being permitted. Existing hazardous- and mixed-waste storage facilities are being included in the site Resource Conservation and Recovery Act (RCRA) Part B Permit. Part B permitting has been initiated for many of the planned hazardous- and mixed-waste treatment and disposal facilities.

5377 (WSRC-TR–93-289) **Semi-annual sampling of Fourmile Branch and its seeplines in the F and H Areas of SRS: July 1992.** Dixon, K.L.; Rogers, V.A. Westinghouse Savannah River Co., Aiken, SC (United States). Apr 1994. 115p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003893. Source: OSTI; NTIS; INIS; GPO Dep.

In July 1992, water samples were collected from Fourmile Branch (FMB) and its seeplines in the vicinity of the F and H-Area seepage basins. The samples were collected from five seepline locations in F Area, five seepline locations in H Area, and three stream locations on FMB. The sampling event was the first in a series of three semi-annual sampling event was the first in a series of three semi-annual sampling events aimed at characterizing the shallow groundwater outcropping into FMB and its wetlands. In the past, this groundwater has been shown to contain contaminants migrating from the F- and H-Area seepage basins. The samples were analyzed for Appendix 9 metals, various radionuclides, selected volatile compounds, and selected inorganic constituents and parameters. Results from the July 1992 sampling event suggest that the seeplines in both F and H Areas and FMB continue to be influenced by contaminants migrating from the F- and H-Area seepage basins. However, when compared to 1989 measurements, the concentrations of most of the constituents have declined. Contaminant concentration measured in July 1992 were compared to primary drinking water standards (PDWS), secondary drinking water standards (SDWS), and maximum contaminant levels (MCL) enforceable in 1993. Results were also compared to 1989 measurements at corresponding sampling locations and to background samples collected as part of the July 1992 sampling event. Using two different statistical tests, concentrations of selected F- and H-Area seepline analytes were compared to background samples. These tests were designed to detect if concentrations of contaminants along the F- and H-Area seeplines were greater than background concentrations.

5378 (WSRC-TR–94-0286-E-Rev.1) **Results of the quarterly tritium survey of Fourmile Branch and its seeplines in the F- and H-Areas of SRS: September 1993. Revision 1.** Dixon, K.L.; Rogers, V.A.; Looney, B.B. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95004410. Source: OSTI; NTIS; INIS; GPO Dep.

The Environmental Sciences Section (ESS) established a quarterly monitoring program of the Fourmile Branch (FMB) seepline down gradient from the F- and H-Area seepage basins. The program surveys and tracks changes in tritium, specific conductivity, and pH for the seepline water. Measurements from the sixth quarterly survey (September 1993) showed higher tritium and conductivity measurements and higher pH values (pH 5–6) than measurements from previous studies. Increased tritium concentrations and conductivity values, as compared to previous surveys, were attributed to decreased rainfall prior to the sampling event. However, overall results of the tritium survey and stream monitoring data (Looney et al., 1993) suggest that the tritium plume is flushing from the FMB system.

5379 (WSRC-TR–94-0484) **Analytical results, database management and quality assurance for analysis of soil and groundwater samples collected by cone penetrometer from the F and H Area seepage basins.** Boltz, D.R.; Johnson, W.H.;

Serkiz, S.M. Westinghouse Savannah River Co., Aiken, SC (United States). Oct 1994. 536p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003927. Source: OSTI; NTIS; INIS; GPO Dep.

The Quantification of Soil Source Terms and Determination of the Geochemistry Controlling Distribution Coefficients (K_d values) of Contaminants at the F- and H-Area Seepage Basins (FHSB) study was designed to generate site-specific contaminant transport factors for contaminated groundwater downgradient of the Basins. The experimental approach employed in this study was to collect soil and its associated porewater from contaminated areas downgradient of the FHSB. Samples were collected over a wide range of geochemical conditions (e.g., pH, conductivity, and contaminant concentration) and were used to describe the partitioning of contaminants between the aqueous phase and soil surfaces at the site. The partitioning behavior may be used to develop site-specific transport factors. This report summarizes the analytical procedures and results for both soil and porewater samples collected as part of this study and the database management of these data.

5380 (WSRC-TR–94-0510) **Lettuce seed germination and root elongation toxicity evaluation of the F-Area seepline soils.** Nelson, E.A.; Westbury, H.M. Jr. Westinghouse Savannah River Co., Aiken, SC (United States). Sep 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003892. Source: OSTI; NTIS; INIS; GPO Dep.

This study is a continuation of similar studies conducted by Easton and Murphy (1993) and Loehle (1990). The objectives of these studies are to: (1) assess the toxicity of the water-soluble constituents of soil in a seepline adjacent to the F-Area Seepage Basins and (2) evaluate the effectiveness of rainwater movements in reducing the toxicity of the soil. Soils from the F-Area seepline that were found to inhibit lettuce seed germination and radical elongation in 1990 were not found to be significantly different from soils from an uncontaminated control site in this test. After six washings of the soil, the toxicity of the leachate was comparable to that of de-ionized water. This indicates that natural water movements may have rendered the F-Area seepline soils less toxic to lettuce seedlings than in previous tests.

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Refer also to citation(s) 5095, 5109, 5110, 5111, 5112, 5113, 5136, 5137, 5138, 5139, 5140, 5141, 5142, 5151, 5157, 5175, 5176, 5190, 5191, 5194, 5197, 5198, 5200, 5201, 5222, 5228, 5229, 5268, 5272, 5278, 5280, 5288, 5298, 5309, 5315, 5319, 5323, 5325, 5328, 5329, 5331, 5332, 5335, 5354, 5355, 5356, 5357, 5358, 5359, 5360, 5374, 5470, 5993, 6562, 6563, 7072, 7074, 7075

5381 (ANL/EAD/TM–34) **Derivation of residual radioactive material guidelines for 13 radionuclides present in Operable Unit IV at Brookhaven National Laboratory, Upton, New York.** Faillace, E.; Nimmagadda, M.; Yu, C. Argonne National Lab., IL (United States). Environmental Assessment Div. Dec 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95004273. Source: OSTI; NTIS; INIS; GPO Dep.

Residual radioactive material guidelines for 13 radionuclides (americium-241; cobalt-60; cesium-137; europium-152, -154, and -155; plutonium-238, -239, and -240; strontium-90; and uranium-234, -235, and -238) were derived for Operable Unit (OU) IV at Brookhaven National Laboratory. This site has been identified for remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986. Single-nuclide guidelines were derived on the basis of the requirement that the 50-year committed effective dose equivalent to a hypothetical individual who lives or works in the immediate vicinity of OU IV should not exceed a dose constraint of 30 mrem/yr following remedial action for the current use and plausible future use scenarios or a dose limit of 100 mrem/yr for plausible but less likely future use scenarios. The US Department of Energy (DOE) residual radioactive material guideline computer code, RESRAD, was used in this evaluation; RESRAD implements the methodology described in the DOE manual for determining residual radioactive material guidelines. Four potential scenarios were considered; each assumed that, for a period of 1,000 years following remedial action, the site would be used without radiological restrictions. The four scenarios varied with regard to the type of site use, time spent at the site, and sources of food consumed.

5382 (ANL/ESD/TM–61) **Initial building investigations at Aberdeen Proving Ground, Maryland: Objectives and methodology.** Brubaker, K.L.; Dougherty, J.M.; McGinnis, L.D. Argonne National Lab., IL (United States). Dec 1994. 32p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95005060. Source: OSTI; NTIS; GPO Dep.

As part of an environmental-contamination source-definition program at Aberdeen Proving Ground, detailed internal and external inspections of 23 potentially contaminated buildings are being conducted to describe and characterize the state of each building as it currently exists and to identify areas potentially contaminated with toxic or other hazardous substances. In addition, a detailed geophysical investigation is being conducted in the vicinity of each target building to locate and identify subsurface structures, associated with former building operations, that are potential sources of contamination. This report describes the objectives of the initial building inspections, including the geophysical investigations, and discusses the methodology that has been developed to achieve these objectives.

5383 (ANL/ESD/TM–73) **Demonstration and evaluation of the pulsed ultraviolet-irradiation gas-treatment system, Savannah River Site.** Schneider, J. (Argonne National Lab., IL (United States). Energy Systems Div.); Wilkey, M.; Peters, R.; Tomczyk, N.; Friedlund, J.; Farber, P.; Mass, B.; Haag, W. Argonne National Lab., IL (United States). Energy Systems Div. Oct 1994. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95004813. Source: OSTI; NTIS; INIS; GPO Dep.

Argonne National Laboratory was asked to demonstrate and evaluate a pulsed ultraviolet-irradiation system developed by Purus, Inc., at the Volatile Organic Compounds Non-Arid Integrated Demonstration at the Savannah River Site near aiken, South Carolina. The Purus system consists of four reactor chambers, each containing a xenon flash lamp. During the two weeks of testing, samples were taken and analyzed from the inlet and outlet sides of the Purus system. The contaminants of concern on the inlet were tetrachloroethylene (PCE), trichloroethylene (TCE), and 1,1,1-trichloroethane (TCA); the contaminants of concern on the outlet were PCE, TCE, TCA, carbon tetrachloride (CT), and chloroform. The evaluation of the Purus system included an examination of the reduction of both TCE and PCE and a search for any change in the concentrations. (Operating conditions included flow rates, ranging from 25 to 100 standard cubic feet per minute; inlet concentration of PCE, ranging from 360 to 10,700 parts per million volume; and flash lamp rates, ranging from 1 to 30 hertz.) The Purus system was quite efficient at reducing the concentrations of both PCE and TCE. The potential by-products, TCA, CT, and chloroform, showed no significant increases throughout the range of the various operating parameters. Overall, the Purus system appears to be a cost-efficient means of reducing the concentrations of PCE and TCE, while the removal of the initial photo-oxidation products and TCA is slower and needs further evaluation.

5384 (BNL–60977) **In-situ containment and stabilization of buried waste: Annual report FY 1994.** Allan, M.L. (Brookhaven National Lab., Upton, NY (United States). Energy Efficiency and Conservation Div.); Kukacka, L.E. Brookhaven National Lab., Upton, NY (United States). Oct 1994. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95003953. Source: OSTI; NTIS; INIS; GPO Dep.

The two landfills of specific interest are the Chemical Waste Landfill (CWL) and the Mixed Waste Landfill (MWL), both located at Sandia National Laboratory. The work is comprised of two subtasks: (1) In-Situ Barriers and (2) In-Situ Stabilization of Contaminated Soils. The main environmental concern at the CWL is a chromium plume resulting from disposal of chromic acid and

chromic sulfuric acid into unlined pits. This program has investigated means of in-situ stabilization of chromium contaminated soils and placement of containment barriers around the CWL. The MWL contains a plume of tritiated water. In-situ immobilization of tritiated water with cementitious grouts was not considered to be a method with a high probability of success and was not pursued. This is discussed further in Section 5.0. Containment barriers for the tritium plume were investigated. FY 94 work focused on stabilization of chromium contaminated soil with blast furnace slag modified grouts to bypass the stage of pre-reduction of Cr(6), barriers for tritiated water containment at the MWL, continued study of barriers for the CWL, and jet grouting field trials for CWL barriers at an uncontaminated site at SNL. Cores from the FY 93 permeation grouting field trails were also tested in FY 94.

5385 (CONF-940225–120) **Physicochemical and mineralogical characterization of uranium-contaminated soils from the Fernald Integrated Demonstration Site.** Elless, M.P.; Lee, S.Y.; Timpson, M.E. Oak Ridge National Lab., TN (United States). [1994]. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Waste management '94; Tucson, AZ (United States); 27 Feb - 3 mar 1994. Order Number DE94017703. Source: OSTI; NTIS; INIS; GPO Dep.

An integrated approach that utilizes various characterization technologies has been developed for the Uranium Soil Integrated Demonstration program. The Fernald Environmental Restoration Management Corporation site near Cincinnati, Ohio, was selected as the host facility for this demonstration. Characterization of background, untreated contaminated, and treated contaminated soils was performed to assess the contamination and the effect of treatment efforts to remove uranium from these soils. Carbonate minerals were present in the contaminated soils (added for erosion control) but were absent in the nearby background soils. Because of the importance of the carbonate anion to uranium solubility, the occurrence of carbonate minerals in these soils will be an important factor in the development of a successful remediation technology. Uranium partitioning data among several particle-size fractions indicate that conventional soil washing will be ineffective for remediation of these soils and that chemical extraction will be necessary to lower the uranium concentration to the target level (52 mg/kg). Carbonate-based (sodium carbonate/bicarbonate) and acid-based (sulfuric and citric acids) lixiviants were employed for the selective removal of uranium from these soils. Characterization results have identified uranium phosphate minerals as the predominant uranium mineral form in both the untreated and treated soils. The low solubility associated with phosphate minerals is primarily responsible for their occurrence in the posttreated soils. Artificial weathering of the treated soils caused by the treatments, particularly acid-based lixiviants, was documented by their detrimental effects on several physicochemical characteristics of these soils (e.g., soil pH, particle-size distribution, and mineralogy).

5386 (DOE/AL/62350–5-Rev.1) **Uranium Mill Tailings Remedial Action Project Safety Advancement Field Effort (SAFE) Program.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Feb 1994. 151p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003917. Source: OSTI; NTIS; INIS; GPO Dep.

In 1992, the Uranium Mill Tailings Remedial Action (UMTRA) Project experienced several health and safety related incidents at active remediation project sites. As a result, the U.S. Department of Energy (DOE) directed the Technical Assistance Contractor (TAC) to establish a program increasing the DOE's overall presence at operational remediation sites to identify and minimize risks in operations to the fullest extent possible (Attachments A and B). In response, the TAC, in cooperation with the DOE and the Remedial Action Contractor (RAC), developed the Safety Advancement Field Effort (SAFE) Program.

5387 (DOE/AL/62350–79-Rev.1) **Uranium Mill Tailings Remedial Action Project environmental protection implementation plan.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Oct 1994. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003909. Source: OSTI; NTIS; INIS; GPO Dep.

The Uranium Mill Tailings Remedial Action (UMTRA) Project Environmental Protection Implementation Plan (EPIP) has been prepared in accordance with the requirements of the U.S. Department of Energy (DOE) Order 5400.1. The UMTRA EPIP is updated annually. This version covers the time period of 9 November 1994, through 8 November 1995. Its purpose is to provide management direction to ensure that the UMTRA Project is operated and managed in a manner that will protect, maintain, and where necessary, restore environmental quality, minimize potential threats to public health and the environment, and comply with environmental regulations and DOE policies.

5388 (DOE/AL/62350–116) **Baseline risk assessment of ground water contamination at the Uranium Mill Tailings Site near Green River, Utah.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 190p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003908. Source: OSTI; NTIS; INIS; GPO Dep.

This document evaluates potential impacts to public health and the environment resulting from ground water contamination at the former uranium mill processing site. The tailings and other contaminated material at this site were placed in a disposal cell on the site in 1989 by the US DOE's Uranium Mill Tailings Remedial Action (UMTRA) Project. Currently, UMTRA Project is evaluating ground water contamination in this risk assessment.

5389 (DOE/AL/62350–132-Rev.1) **UMTRA Project water sampling and analysis plan, Gunnison, Colorado: Revision 1.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 71p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003886. Source: OSTI; NTIS; INIS; GPO Dep.

This water sampling and analysis plan summarizes the results of previous water sampling activities and the plan for future water sampling activities, in accordance with the Guidance Document for Preparing Sampling and Analysis Plans for UMTRA Sites. A buffer zone monitoring plan for the Dos Rios Subdivision is included as an appendix. The buffer zone monitoring plan was developed to ensure continued protection to the public from residual contamination. The buffer zone is beyond the area depicted as contaminated ground water due to former milling operations. Surface remedial action at the Gunnison Uranium Mill Tailings Remedial Action Project site began in 1992; completion is expected in 1995. Ground water and surface water will be sampled semiannually at the Gunnison processing site and disposal site. Results of previous water sampling at the Gunnison processing site indicate that ground water in the alluvium is contaminated by the former uranium processing activities. Background ground water conditions have been established in the uppermost aquifer at the Gunnison disposal site. The monitor well locations provide a representative distribution of sampling points to characterize ground water quality and ground water flow conditions in the vicinity of the sites. The list of analytes has been modified with time to reflect constituents that are related to uranium processing activities and the parameters needed for geochemical evaluation.

5390 (DOE/AL/62350–159) **Site observational work plan for the UMTRA Project site at Ambrosia Lake, New Mexico.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Sep 1994. 498p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003891. Source: OSTI; NTIS; INIS; GPO Dep.

The Ambrosia Lake Uranium Mill Tailings Remedial Action (UMTRA) Project site is within the Grants Mineral Belt and was one of numerous uranium mills supplied by many local mines. Ground water contamination at the site occurred as a result of uranium mill operations. The potential for impacts to human health and the environment from contaminated ground water currently does not exist. No domestic or livestock wells accessing ground water from the uppermost aquifer have been identified within a 5 mile radius from the site. Therefore, no current exposure pathways to humans, livestock, or wildlife exist, nor are any foreseen. The proposed ground water compliance strategy under consideration for application at the Ambrosia Lake site is to perform no remediation, based on the

application of supplemental standards because the ground water has "limited use."

5391 (DOE/AL/62350–169-Rev.1) **Proposed ground water protection strategy for the Uranium Mill Tailings Site at Green River, Utah. Final report.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003914. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the US DOE water resources protection strategy for the Green River, Utah mill tailings disposal site. The modifications in the original plan are based on new information, including ground water quality data collected after remedial action was completed, and on a revised assessment of disposal cell design features, surface conditions, and site hydrogeology. All aspects are discussed in this report.

5392 (DOE/AL/62350–170) **Human health risk assessment methodology for the UMTRA Ground Water Project.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 37p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003883. Source: OSTI; NTIS; INIS; GPO Dep.

This document presents the method used to evaluate human risks associated with ground water contamination at inactive uranium processing sites. The intent of these evaluations is to provide the public and remedial action decision-makers with information about the health risks that might be expected at each site in a manner that is easily understood. The method (1) develops probabilistic distributions for exposure variables where sufficient data exist, (2) simulates predicted exposure distributions using Monte Carlo techniques, and (3) develops toxicity ranges that reflect human data when available, animal data if human data are insufficient, regulatory levels, and uncertainties. Risk interpretation is based on comparison of the potential exposure distributions with the derived toxicity ranges. Graphic presentations are an essential element of the semiquantitative interpretation and are expected to increase understanding by the public and decision-makers.

5393 (DOE/AL/62350–174) **Economic impact study of the Uranium Mill Tailings Remedial Action Project in Colorado: Colorado state fiscal year 1994.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003884. Source: OSTI; NTIS; INIS; GPO Dep.

The Colorado economic impact study summarizes employment and economic benefits to the state from activities associated with the Uranium Mill Tailings Remedial Action (UMTRA) Project during Colorado state fiscal year 1994. To capture employment information, a questionnaire was distributed to subcontractor employees at the active UMTRA Project sites of Grand Junction, Naturita, Gunnison, and Rifle, Colorado. Economic data were requested from each site prime subcontractor, as well as from the Remedial Action Contractor. The most significant benefits associated with the UMTRA Project in Colorado are summarized. This study assesses benefits associated with the Grand Junction, Gunnison, Naturita, and Rifle UMTRA Projects sites for the 1-year period under study. Work at the Naturita site was initiated in April 1994 and involved demolition of buildings at the processing site. Actual start-up of remediation of Naturita is planned to begin in the spring of 1995. Work at the Slick Rock and Maybell sites is expected to begin in 1995. The only current economic benefits associated with these sites are related to UMTRA Project support work.

5394 (DOE/AL/62350–T5) **Finding of No Significant Impact, proposed remediation of the Maybell Uranium Mill Processing Site, Maybell, Colorado.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). [1995]. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003925. Source: OSTI; NTIS; INIS; GPO Dep.

The U.S. Department of Energy (DOE) has prepared an environmental assessment (EA) (DOE/EA-0347) on the proposed surface remediation of the Maybell uranium mill processing site in Moffat County, Colorado. The mill site contains radioactively contaminated materials from processing uranium ore that would be stabilized in place at the existing tailings pile location. Based on the analysis in the EA, DOE has determined that the proposed action does not constitute a major federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA) of 1969, Public Law 91-190 (42 U.S.C. §4321 et seq.), as amended. Therefore, preparation of an environmental impact statement is not required and DOE is issuing this Finding of No Significant Impact (FONSI).

5395 (DOE/EA–0347-Rev.2) **Environmental assessment of remedial action at the Maybell uranium mill tailings site near Maybell, Colorado: Revision 2.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Nov 1994. 137p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003887. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this environmental assessment (EA) is to evaluate the environmental impacts resulting from remedial action at the Maybell uranium mill tailings site near Maybell, Colorado. A biological assessment and a floodplain/wetlands assessment are included as part of this EA. This report and attachments describe the proposed action, affected environment, and environmental impacts associated with the proposed remedial action, including impacts to threatened and endangered species listed or proposed for listing by the US Fish and Wildlife Service (FWS).

5396 (DOE/EA–0464-Rev.5) **Environmental assessment of remedial action at the Naturita uranium processing site near Naturita, Colorado: Revision 5.** Jacobs Engineering Group, Inc., Albuquerque, NM (United States). Oct 1994. 159p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-91AL62350. Order Number DE95003888. Source: OSTI; NTIS; INIS; GPO Dep.

Title 1 of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Public Law (PL) 95-604, authorized the US Department of Energy (DOE) to perform remedial action at the inactive Naturita, Colorado, uranium processing site to reduce the potential health effects from the radioactive materials at the site and at vicinity properties associated with the site. Title 2 of the UMTRCA authorized the US Nuclear Regulatory Commission (NRC) or agreement state to regulate the operation and eventual reclamation of active uranium processing sites. The uranium mill tailings at the site were removed and reprocessed from 1977 to 1979. The contaminated areas include the former tailings area, the mill yard, the former ore storage area, and adjacent areas that were contaminated by uranium processing activities and wind and water erosion. The Naturita remedial action would result in the loss of 133 acres (ac) of contaminated soils at the processing site. If supplemental standards are approved by the NRC and the state of Colorado, approximately 112 ac of steeply sloped contaminated soils adjacent to the processing site would not be cleaned up. Cleanup of this contamination would have adverse environmental consequences and would be potentially hazardous to remedial action workers.

5397 (DOE/EH–0430) **Radiation exposures for DOE and DOE contractor employees - 1991. Twenty-fourth annual report.** Smith, M.H. (Pacific Northwest Lab., Richland, WA (United States)); Hui, T.E.; Millet, W.H.; Scholes, V.A. USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States); Pacific Northwest Lab., Richland, WA (United States). Nov 1994. 134p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95003788. Source: OSTI; NTIS; INIS; GPO Dep.

This is the 24th annual radiation exposure report published by US DOE and its predecessor agencies. This report summarizes the radiation exposures received by both employees and visitors at DOE and COE contractor facilities during 1991. Trends in radiations exposures are evaluated. The significance of the doses is addressed by comparing them to the DOE limits and by correlating the doses to health risks based on risk estimates from expert groups.

5398 (DOE/EIS–0195D-Vol.1) **Feasibility study report for Operable Unit 4: Volume 1.** Fernald Environmental Restoration

Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. Feb 1994. 686p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004461. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report documents the Feasibility Study (FS) phase of the Fernald Environmental Management Project (FEMP) Operable Unit 4 Remedial Investigation/Feasibility Study (RI/FS) Program. The FEMP, formerly known as the Feed Materials Production Center (FMPC), is a US Department of Energy (DOE) facility that operated from 1952 to 1989. The facility's primarily function was to provide high purity uranium metal products to support United States defense programs. Production operations were suspended in 1989 to focus on environmental restoration and waste management activities at the facility. The RI/FS is being conducted pursuant to the terms of a Consent Agreement between DOE and the US Environmental Protection Agency (EPA) under Sections 120 and 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The Ohio Environmental Protection Agency (OEPA) is also participating in the RI/FS process at the FEMP through direct involvement in program review meetings and technical review of project documentation. The objective of the RI/FS process is to gather information to support an informed risk management decision regarding which remedy appears to be the most appropriate action for addressing the environmental concerns identified at the FEMP.

5399 (DOE/EIS–0195D-Vol.2) **Feasibility study report for Operable Unit 4: Volume 2.** Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. Feb 1994. 774p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004462. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report documents the Feasibility Study (FS) phase of the Fernald Environmental Management Project (FEMP) Operable Unit 4 Remedial Investigation/Feasibility Study (RI/FS) Program. The FEMP, formerly known as the Feed Materials Production Center (FMPC), is a US Department of Energy (DOE) facility that operated from 1952 to 1989. The facility's primarily function was to provide high purity uranium metal products to support United States defense programs. Production operations were suspended in 1989 to focus on environmental restoration and waste management activities at the facility. The RI/FS is being conducted pursuant to the terms of a Consent Agreement between DOE and the US Environmental Protection Agency (EPA) under Sections 120 and 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The Ohio Environmental Protection Agency (OEPA) is also participating in the RI/FS process at the FEMP through direct involvement in program review meetings and technical review of project documentation. The objective of the RI/FS process is to gather information to support an informed risk management decision regarding which remedy appears to be the most appropriate action for addressing the environmental concerns identified at the FEMP. This volume contains appendices A–E.

5400 (DOE/EIS–0195D-Vol.3) **Feasibility study report for Operable Unit 4: Fernald Environmental Management Project, Fernald, Ohio: Remedial investigation and feasibility study: Volume 3: Final report.** USDOE Fernald Field Office, OH (United States). Feb 1994. 769p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004463. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report documents the Feasibility Study (FS) phase of the Fernald Environmental Management Project (FEMP) Operable Unit 4 Remedial Investigation/Feasibility Study (RI/FS) Program. The FEMP, formerly known as the Feed Materials Production Center (FMPC), is a US Department of Energy (DOE) facility that operated from 1952 to 1989. The facility's primarily function was to provide high purity uranium metal products to support United States defense programs. Production operations were suspended in 1989 to focus on environmental restoration and waste management activities at the facility. The RI/FS is being conducted pursuant to the terms of a Consent Agreement between DOE and the US Environmental Protection Agency (EPA) under Sections 120 and 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The Ohio Environmental Protection Agency (OEPA) is also participating in the RI/FS process at the FEMP through direct involvement in program review meetings and technical review of project documentation. The objective of the RI/FS process is to gather information to support an informed risk management decision regarding which remedy appears to be the most appropriate action for addressing the environmental concerns identified at the FEMP. This volume contains appendices F–J.

5401 (DOE/EIS–0195D-Vol.4) **Feasibility study report for Operable Unit 4: Volume 4.** Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. Feb 1994. 819p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004464. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report documents the Feasibility Study (FS) phase of the Fernald Environmental Management Project (FEMP) Operable Unit 4 Remedial Investigation/Feasibility Study (RI/FS) Program. The FEMP, formerly known as the Feed Materials Production Center (FMPC), is a US Department of Energy (DOE) facility that operated from 1952 to 1989. The facility's primarily function was to provide high purity uranium metal products to support United States defense programs. Production operations were suspended in 1989 to focus on environmental restoration and waste management activities at the facility. The RI/FS is being conducted pursuant to the terms of a Consent Agreement between DOE and the US Environmental Protection Agency (EPA) under Sections 120 and 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The Ohio Environmental Protection Agency (OEPA) is also participating in the RI/FS process at the FEMP through direct involvement in program review meetings and technical review of project documentation. The objective of the RI/FS process is to gather information to support an informed risk management decision regarding which remedy appears to be the most appropriate action for addressing the environmental concerns identified at the FEMP.

5402 (DOE/EM–0197) **Guidance for establishment and implementation of field sample management programs in support of EM environmental sampling and analysis activities.** National Cold Fusion Inst., Salt Lake City, UT (United States). 18 Feb 1994. 12p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004245. Source: OSTI; NTIS; INIS; GPO Dep.

The role of the National Sample Management Program (NSMP) proposed by the Department of Energy's Office of Environmental Management (EM) is to be a resource for EM programs and for local Field Sample Management Programs (FSMPs). It will be a source of information on sample analysis and data collection within the DOE complex. The purpose of this document is to establish the suggested scope of the FSMP activities to be performed under each Operations Office, list the drivers under which the program will operate, define terms and list references. This guidance will apply only to EM sampling and analysis activities associated with project planning, contracting, laboratory selection, sample collection, sample transportation, laboratory analysis and data management.

5403 (DOE/EM–0198) **Guidance for establishment and implementation of a national sample management program in support of EM environmental sampling and analysis activities.** Centenary Coll., Shreveport, LA (United States). 18 Feb 1994. 9p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004244. Source: OSTI; NTIS; INIS; GPO Dep.

The role of the National Sample Management Program (NSMP) proposed by the Department of Energy's Office of Environmental Management (EM) is to be a resource for EM programs and for local Field Sample Management Programs (FSMPs). It will be a source of information on sample analysis and data collection within the DOE complex. Therefore the NSMP's primary role is to coordinate and function as a central repository for information collected from the FSMPs. An additional role of the NSMP is to monitor trends in data collected from the FSMPs over time and across sites and laboratories. Tracking these trends will allow identification of potential problems in the sampling and analysis process.

5404 (DOE/EM–0201) **In Situ Remediation Integrated Program: Evaluation and assessment of containment technology.**

Gerber, M.A.; Fayer, M.J. Pacific Northwest Lab., Richland, WA (United States). Jun 1994. 99p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95003293. Source: OSTI; NTIS; INIS; GPO Dep.

Containment technology refers to a broad range of methods that are used to contain waste or contaminated groundwater and to keep uncontaminated water from entering a waste site. The U.S. Department of Energy's (DOE) Office of Technology Development has instituted the In Situ Remediation Integrated Program (ISRIP) to advance the state-of-the-art of innovative technologies that contain or treat, in situ, contaminated media such as soil and groundwater, to the point of demonstration and to broaden the applicability of these technologies to the widely varying site remediation requirements throughout the DOE complex. The information provided here is an overview of the state-of-the-art of containment technology and includes a discussion of ongoing development projects; identifies the technical gaps; discusses the priorities for resolution of the technical gaps; and identifies the site parameters affecting the application of a specific containment method. The containment technology described in this document cover surface caps; vertical barriers such as slurry walls, grout curtains, sheet pilings, frozen soil barriers, and vitrified barriers; horizontal barriers; sorbent barriers; and gravel layers/curtains. Within DOE, containment technology could be used to prevent water infiltration into buried waste; to provide for long-term containment of pits, trenches, and buried waste sites; for the interim containment of leaking underground storage tanks and piping; for the removal of contaminants from groundwater to prevent contamination from migrating off-site; and as an interim measure to prevent the further migration of contamination during the application of an in situ treatment technology such as soil flushing. The ultimate goal is the implementation of containment technology at DOE sites as a cost-effective, efficient, and safe choice for environmental remediation and restoration activities.

5405 (DOE/EM–0216) **FY 1994 program summary: Office of Technology Development, Office of Research and Development, Office of Demonstration, Testing, and Evaluation.** USDOE Assistant Secretary for Environmental Restoration and Waste Management, Washington, DC (United States). Office of Environmental Restoration. Oct 1994. 242p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003756. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) Office of Environmental Management, formerly the Office of Environmental Restoration and Waste Management (EM), was established in November 1989 as the first step toward correcting contamination problems resulting from nearly 50 years of nuclear weapons production and fuel processing activities. EM consolidates several DOE organizations previously responsible for the handling, treatment, and disposition of radioactive and hazardous waste. Within EM, the Office of Technology Development (OTD/EM-50) is responsible for developing technologies to meet DOE's goal for environmental restoration. OTD manages an aggressive national program of applied research, development, demonstration, testing, and evaluation (RDDT and E) for environmental cleanup, waste management, and related technologies. The program is designed to resolve major technical issues, to rapidly advanced beyond current technologies for environmental restoration and waste management operations, and to expedite compliance with applicable environmental laws and regulations. This report summarizes Fiscal Year 1994 (FY94) programmatic information, accomplishments, and planned activities relevant to the individual activities within OTD's RDDT and E.

5406 (DOE/EM–0226) **Chicago Operations Office: Technology summary.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Office of Technology Development. Dec 1994. 208p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004984. Source: OSTI; NTIS; INIS; GPO Dep.

This document has been prepared by the Department of Energy's (DOE) Environmental Management (EM) Office of Technology Development (OTD) to highlight its research, development, demonstration, testing, and evaluation (RDDT and E) activities funded through the Chicago Operations Office. Technologies and processes described have the potential to enhance DOE's cleanup and waste management efforts, as well as improve US Industry's competitiveness in global environmental markets. The information has been assembled from recently produced OTD documents which highlight technology development activities within each of the OTD program elements. OTD technologies addresses three specific problem areas: (1) groundwater and soils cleanup; (2) waste retrieval and processing; and (3) pollution prevention. These problems are not unique to DOE, but are associated with other Federal agency and industry sites as well. Thus, technical solutions developed within OTD programs will benefit DOE, and should have direct applications in outside markets.

5407 (DOE-HDBK–1081-94) **Primer on spontaneous heating and pyrophoricity.** USDOE, Washington, DC (United States). Dec 1994. 89p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003576. Source: OSTI; NTIS; GPO Dep.

This primer was prepared as an information resource for personnel responsible for operation of DOE nuclear facilities. It has sections on combustion principles, spontaneous heating/ignition of hydrocarbons and organics, pyrophoric gases and liquids, pyrophoric nonmetallic solids, pyrophoric metals (including Pu and U), and accident case studies. Although the information in this primer is not all-encompassing, it should provide the reader with a fundamental knowledge level sufficient to recognize most spontaneous combustion hazards and how to prevent ignition and widespread fires. This primer is provided as an information resource only, and is not intended to replace any fire protection or hazardous material training.

5408 (DOE/ID–12082(93)) **The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993.** Mitchell, R.G. Environmental Science and Research Foundation, Idaho Falls, ID (United States). Jul 1994. 141p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AS07-80ID12082. (INEL/MISC–94075). Order Number DE95002023. Source: OSTI; NTIS; INIS; GPO Dep.

Results of the various environmental monitoring programs for 1993 are presented from the Idaho National Engineering Laboratory (INEL) operations. Although some radioactive materials were discharged during Site operations, concentrations and doses to the surrounding population were of no health consequence and were far less than State of Idaho and Federal health protection guidelines. Chapter 2 summarizes INEL activities related to compliance with environmental regulations and laws for Calendar Year 1993. The major portion of the report summarizes results of the environmental surveillance program conducted by the DOE Radiological and Environmental Sciences Laboratory, which includes the collection of foodstuffs at the INEL boundary and distant offsite locations, and the collection of air and water samples at onsite locations and offsite boundary and distant locations. The report also compares and evaluates the sample results to appropriate federal regulations and standards and discusses implications, if any. The US Geological Survey (USGS) ground-water monitoring program is briefly summarized and data are included in maps showing the spread of contaminants. Effluent monitoring and nonradiological drinking water monitoring are discussed briefly and data are summarized.

5409 (DOE/MC/29116–3858) **Novel mass spectrometric instrument for gaseous and particulate characterization and monitoring. Quarterly report, January 1, 1994–March 31, 1994.** Coggiola, M.J. SRI International, Menlo Park, CA (United States). May 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-92MC29116. Order Number DE94017588. Source: OSTI; NTIS; GPO Dep.

SRI International will develop a unique new instrument that will be capable of providing real-time (<1 minute), quantitative, chemical characterization of gaseous and particulate pollutants generated from DOE waste cleanup activities. The instrument will be capable of detecting and identifying volatile organic compounds, polynuclear aromatic hydrocarbons, heavy metals, and transuranic species released during waste cleanup activities. The instrument will be unique in its ability to detect and quantify in real-time these diverse pollutants in both vapor and particulate form. The instrument to be developed under this program will consist of several

major components: (1) an isokinetic sampler capable of operating over a wide range of temperatures (up to 500 K) and flow rates; (2) a high pressure to low pressure transition and sampling region that efficiently separates particles from vapor-phase components for separate, parallel analyses; (3) two small mass spectrometers, one optimized for organic analysis using a unique field ionization source and one optimized for particulate characterization using thermal pyrolysis and electron-impact ionization (EI); and (4) a powerful personal computer for control and data acquisition.

5410 (DPW–56-419) **Reference: SR-TP-3625.** Christl, R.J. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Explosives Dept. 26 Nov 1956. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–791). Order Number DE94018522. Source: OSTI; NTIS; GPO Dep.

The reference letter dated October 4, 1956, requested that they review the possibilities of a crippling accident in 232-H and the measures which might be taken to minimize the loss in tritium production associated with such an accident be reviewed. These subjects have been reviewed in considerable detail and the authors feel that the chances of a crippling accident are quite remote. In arriving at this conclusion, the entire process was reviewed and the following three incidents were selected as having the most serious potential. (1) a tank containing tritium at subatmospheric pressure develops a leak and becomes contaminated with air equalized to atmospheric pressure; (2) a flange is removed inadvertently or a nozzle breaks on a tank containing tritium at 15 psig; (3) the water jacket on the extraction furnace ruptures internally, particularly when the charge is molten. From the foregoing, it may be concluded that a serious accident in one line is unlikely to shut down the other from the standpoint of either physical damage or serious contamination. It should be recognized that some outage, perhaps a matter of days or even weeks, could result while safety of operation is assured. Insofar as procurement of long delivery equipment is concerned, it is felt that the normal extra machinery is sufficient to permit rehabilitating a line as fast as the work can be done. With respect to equipment for erection of an entirely new line, the attached list summarizes the most urgent requirements with a total value of about $1,400,000. In answer to the question concerning the increase in 232-F capacity, there has been insufficient time to fully evaluate this problem.

5411 (ES/ER/TM–98) **Annual summary of the contents of the Oak Ridge Environmental Information System (OREIS) 1993 data base.** McCord, R.A.; Herr, D.D.; Durfee, R.C.; Land, M.L.; Monroe, F.E.; Olson, R.J.; Thomas, J.K.; Tinnel, E.P. Oak Ridge National Lab., TN (United States). Jun 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE94017745. Source: OSTI; NTIS; INIS; GPO Dep.

The data base of the Oak Ridge Environmental Information System (OREIS) contains data of known quality that can be accessed by OREIS users. OREIS meets data management/access requirements for environmental data as specified in the Federal Facility Agreement for the Oak Ridge Reservation and the State Oversight Agreement between the State of Tennessee and the Department of Energy. The types of environmental data within OREIS include measurement data from the following environmental disciplines: groundwater, surface water, sediment, soils, air, and biota. In addition to measurement data, the OREIS data base contains extensive descriptive and qualifier metadata to help define data quality and to enable end users to analyze the appropriateness of data for their purposes. Another important aspect of measurement data is their spatial context; OREIS maintains a comprehensive library of geographic data and tools to analyze and display spatial relationships of the data. As of November 1993, the OREIS data base consists of approximately 100,000 records associated with three environmental restoration projects along with coordinate data and background map data. The data base also contains 2,700 supporting codes and other reference data records. Geographic data include the S-16A base map for the Oak Ridge Reservation, boundaries for operable units, and high-resolution raster images for each of the sites.

5412 (ES/ER/TM–136) **Environmental Restoration Program waste minimization and pollution prevention self-assessment.** Oak Ridge National Lab., TN (United States); Radian Corp., Oak Ridge, TN (United States). Oct 1994. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003903. Source: OSTI; NTIS; INIS; GPO Dep.

The Environmental Restoration (ER) Program within Martin Marietta Energy Systems, Inc. is currently developing a more active waste minimization and pollution prevention program. To determine areas of programmatic improvements within the ER Waste Minimization and Pollution Prevention Awareness Program, the ER Program required an evaluation of the program across the Oak Ridge K-25 Site, the Oak Ridge National Laboratory, the Oak Ridge Y-12 Plant, the Paducah Environmental Restoration and Waste Minimization Site, and the Portsmouth Environmental Restoration and Waste Minimization Site. This document presents the status of the overall program as of fourth quarter FY 1994, presents pollution prevention cost avoidance data associated with FY 1994 activities, and identifies areas for improvement. Results of this assessment indicate that the ER Waste Minimization and Pollution Prevention Awareness Program is firmly established and is developing rapidly. Several procedural goals were met in FY 1994 and many of the sites implemented ER waste minimization options. Additional growth is needed, however, for the ER Waste Minimization and Pollution Prevention Awareness Program.

5413 (FEMP–2321) **Identifying environmental safety and health requirements for the Fernald Environmental Restoration Management Corporation.** Beckman, W.H. (Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project); Cossel, S.C.; Alhadeff, N.; Porco, D.J.; Lindamood, S.B.; Beers, J.A. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. 14 Jan 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-940632–27: Annual meeting and exhibition of the Air and Waste Management Association, Cincinnati, OH (United States), 19-24 Jun 1994). Order Number DE95003488. Source: OSTI; NTIS; INIS; GPO Dep.

This presentation will describe the Fernald Environmental Restoration Management Corporation's (FERMCO) Standards/Requirements Identification Documents (S/RIDs) Program, the unique process used to implement it, and the status of the program. We will also discuss the lessons learned as the program was implemented. The Department of Energy (DOE) established the Fernald site to produce uranium metals for the nation's defense programs in 1953. In 1989, DOE suspended production and, in 1991, the mission of the site was formally changed to one of environmental cleanup and restoration. The site was renamed the Fernald Environmental Management Project (FEMP). FERMCO's mission is to provide safe, early, and least-cost final clean-up of the site in compliance with all regulations and commitments. DOE has managed nuclear facilities primarily through its oversight of Management and Operating contractors. Comprehensive nuclear industry standards were absent when most DOE sites were first established, Management and Operating contractors had to apply existing non-nuclear industry standards and, in many cases, formulate new technical standards. Because it was satisfied with the operation of its facilities, DOE did not incorporate modern practices and standards as they became available. In March 1990, the Defense Nuclear Facilities Safety Board issued Recommendation 90-2, which called for DOE to identify relevant standards and requirements, conduct adequacy assessments of requirements in protecting environmental, public, and worker health and safety, and determine the extent to which the requirements are being implemented. The Environmental Restoration and Waste Management Office of DOE embraced the recommendation for facilities under its control. Strict accountability requirements made it essential that FERMCO and DOE clearly identify applicable requirements necessary, determine the requirements' adequacy, and assess FERMCO's level of compliance.

5414 (FEMP–2336) **Ensuring comparability of data generated by multiple analytical laboratories for environmental**

decision making at the Fernald Environmental Management Project. Sutton, C.; Campbell, B.A.; Danahy, R.J.; Dugan, T.A.; Tomlinson, F.K. Fluor Daniel Environmental Restoration Management Corp., Fernald, OH (United States). [1994]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-940790–3: 10. annual waste testing and quality assurance symposium, Arlington, VA (United States), 11-15 Jul 1994). Order Number DE94018443. Source: OSTI; NTIS; INIS; GPO Dep.

The Fernald Environmental Management Project is a US Department of Energy (DOE)-owned facility located 17 miles northwest of Cincinnati, Ohio. From 1952 until 1989, the Fernald site provided high-purity uranium metal products to support US defense programs. In 1989 the mission of Fernald changed from one of uranium production to one of environmental restoration. At Fernald, multiple functional programs require analytical data. Inorganic and organic data for these programs are currently generated by seven laboratories, while radiochemical data are being obtained from six laboratories. Quality Assurance (QA) and Quality Control (QC) programs have been established to help ensure comparability of data generated by multiple laboratories at different times. The quality assurance program for organic and inorganic measurements specifies which analytical methodologies and sample preparation procedures are to be used based on analyte class, sample matrix, and data quality requirements. In contrast, performance specifications have been established for radiochemical analyses. A blind performance evaluation program for all laboratories, both on-site and subcontracted commercial laboratories, provides continuous feedback on data quality. The necessity for subcontractor laboratories to participate in the performance evaluation program is a contractual requirement. Similarly, subcontract laboratories are contractually required to generate data which meet radiochemical performance specifications. The Fernald on-site laboratory must also fulfill these requirements.

5415 (FEMP–2338) **Decontamination and dismantlement of Plant 7 at Fernald.** Albertin, M.; Borgman, T.; Zebick, B. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. 7 Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-941148–4: ANS meeting on environmental aspects of decommissioning, decontamination, and/or environmental restoration at nuclear and mixed waste facilities, Washington, DC (United States), 13-17 Nov 1994). Order Number DE95003487. Source: OSTI; NTIS; INIS; GPO Dep.

Decontamination and dismantlement (D&D) tasks have been successfully completed on Plant 7 at the Fernald Environmental Management Project. The seven story facility was radiologically, chemically, and biologically contaminated. The work involved the D&D work beginning with safe shutdown and gross decontamination, and ended with removal of the structural steel. A series of lessons learned were gained which include use of explosives, bidding tactics, safe shutdown, building decontamination and lockdown, use of seam climbers, etc.

5416 (FEMP–2390) **Development of subcontractor indirect cost and other direct cost at the DOE Fernald Site.** Cossman, R.L. (Jacobs Engineering Group, Inc., Pasadena, CA (United States)). Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project. 18 Nov 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. (CONF-941246–1: 2. annual EM cost management conference, San Francisco, CA (United States), 5-9 Dec 1994). Order Number DE95003966. Source: OSTI; NTIS; INIS; GPO Dep.

The Fernald Environmental Restoration Management Corporation (FERMCO) took great strides in the development of cost estimates at Fernald. There have been many opportunities to improve on how the policies and procedures pertaining to cost estimates were to be implemented. As FERMCO took over the existing Fernald facility, the Project Controls Division began to format the estimating procedures and tools to do business at Fernald. The Estimating Department looked at the problems that pre-existed at the site. One of the key problems that FERMCO encountered was how to summarized the direct and indirect accounts of each subcontracted estimate. Direct costs were broken down by prime and sub-prime accounts. This presented a level of detail that had not been experienced at the site before; it also created many issues concerning accounts and definitions to be applied to "all other accounts associated with a project." Existing subcontract indirect cost accounts were reviewed from existing historical estimates. It was found that some were very detailed and some were not. The Estimating Department was given the task of standardizing the accounts and percentages for each of the subcontractor indirect costs. Then, as the project progressed, the percentages could be revised with actual estimates, subcontract comparisons, or with level of effort (LOE) accounts, which would represent qualified people assigned a task for the completion of each project. The approach is to assign particular employees to perform a specific task within a project from start to finish, and then to reassign the individual(s) to a new project (if it was available) integrating the expertise available with the skills required by the other operable units.

5417 (FEMP/SUB–058) **Uranium soils integrated demonstration: Soil characterization project report.** Cunnane, J.C. (Argonne National Lab., IL (United States)); Gill, V.R.; Lee, S.Y.; Morris, D.E.; Nickelson, M.D.; Perry, D.L.; Tidwell, V.C. Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States); Fluor Daniel Environmental Restoration Management Corp., Fernald, OH (United States). Aug 1993. 74p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC24-92OR21972. Order Number DE94018442. Source: OSTI; NTIS; INIS; GPO Dep.

An Integrated Demonstration Program, hosted by the Fernald Environmental Management Project (FEMP), has been established for investigating technologies applicable to the characterization and remediation of soils contaminated with uranium. Critical to the design of relevant treatment technologies is detailed information on the chemical and physical characteristics of the uranium waste-form. To address this need a soil sampling and characterization program was initiated which makes use of a variety of standard analytical techniques coupled with state-of-the-art microscopy and spectroscopy techniques. Sample representativeness is evaluated through the development of conceptual models in an effort to identify and understand those geochemical processes governing the behavior of uranium in FEMP soils. Many of the initial results have significant implications for the design of soil treatment technologies for application at the FEMP.

5418 (HW–74723) **Accidental nuclear excursion Recuplex operation 234-5 facility. Final report: Date of incident: April 7, 1962.** USAEC Hanford Operations Office, Richland, WA (United States). Aug 1962. 206p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94016847. Source: OSTI; NTIS; GPO Dep.

On Saturday morning, April 7, 1962, at about 1059 Armed Forces time, an accidental nuclear excursion occurred in the plutonium waste recovery facility (Recuplex) of the 234-5 Building. This excursion did not result in any mechanical damage or spread of contamination. Three employees of the General Electric Company received overexposures to gamma and neutron radiation. None were fatally exposed; in each case the overexposure was recognized promptly, and following medical observation and testing the men were released to return to work. In compliance with AEC Manual Chapter 0703, an AEC-HAPO committee composed of two AEC employees and five General Electric employees was appointed by the Manger, HOO, with the concurrence of the General Manager, HAPO, to conduct an investigation of the incident. The committee's purpose was to determine the cause, nature, and extent of the incident, and recommend action to be taken by others to minimize or preclude future incidents of this magnitude. A study of operating practices and operating conditions that appeared to exist prior to, during, and subsequent to the accident was made by the committee. The committee believes that this report provides sufficient information to answer questions which may arise as a result of the criticality incident except those relating to its cause.

5419 (ICF–0001) **Landlord Program multi-year program plan fiscal year 1995 WBS 7.5.** Young, C.L. ICF Kaiser Hanford Co., Richland, WA (United States). 26 Sep 1994. 156p. Sponsored

by USDOE, Washington, DC (United States). DOE Contract AC06-93RL12359. Order Number DE95001294. Source: OSTI; NTIS; INIS; GPO Dep.

The Landlord Program mission is to maintain, preserve, or upgrade the strategic assets of the Hanford Site to meet the overall cleanup mission. This encompasses innovative, appropriate, and cost effective general purpose infrastructure support, services, and long range strategic site planning that is the foundation for seven major Hanford programs. These programs are (1) Environmental Restoration, (2) Tank Waste Remediation System, (3) Solid/Liquid Waste Decontamination, (4) Facility Transition, (5) Spent Fuel, (6) Technology Development, and (7) the Multi-Program Laboratory. General infrastructure support consists of facilities, systems, and equipment that by design or use are not essentially dedicated to a single program mission. Facilities include laboratories, shops, warehouses, and general work space. Systems include electrical, process sewers, rail, roads, telecommunications, water, fire and emergency response, and steam supply and distribution. Funding also supports capital equipment critical to maintaining, upgrading, or operating the general infrastructure. Paramount to these objectives is compliance with all applicable laws, orders, agreements, codes, standards, best management and safety practices. The objectives for general infrastructure support are reflected in five programmatic functions, (1) Program Integration, (2) Capital Equipment, (3) Expense Funded Projects, (4) General Plant Projects, and (5) Line Items.

5420 (NUREG/CR–5247-Vol.2-Rev.2) **RASCAL Version 2.1 workbook. Volume 2, Revision 2.** Athey, G.F. (Athey Consulting, Charles Town, WV (United States)); Sjoreen, A.L.; McKenna, T.J. Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data; Athey Consulting, Charles Town, WV (United States). Dec 1994. 139p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; GPO; INIS; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020.

The Radiological Assessment System for Consequence Analysis, Version 2.1 (RASCAL 2.1) was developed for use by the NRC personnel who respond to radiological emergencies. This workbook complements the RASCAL 2.1 User's guide (NUREG/CR-5247, Vol. 1, Rev. 2). The workbook contains exercises designed to familiarize the user with the computer-based tools of RASCAL through hands-on problem solving. The workbook contains four major sections. The first is a RASCAL familiarization exercise to acquaint the user with the operation of the forms, menus, online help, and documentation. The latter three sections contain exercises in using the three tools of RASCAL Version 2.1: DECAY, FM-DOSE, and ST-DOSE. A discussion section describing how the tools could be used to solve the problems follows each set of exercises.

5421 (ORNL/ER–261) **Development of a passive-flow treatment system for ^{90}Sr-contaminated seep water at Waste Area Grouping 5 at Oak Ridge National Laboratory.** Taylor, P.A. Oak Ridge National Lab., TN (United States). Aug 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003901. Source: OSTI; NTIS; INIS; GPO Dep.

Seep C is a free-flowing stream of groundwater (typical flow of 0.2 to 2 L/min) that emerges in a narrow valley below the old low-level waste disposal trenches in Solid Waste Storage Area 5 (SWSA 5), which is part of Waste Area Grouping 5 (WAG 5). The seep water contains high concentrations of Sr-90 (10,000 to 20,000 Bq/L) and contributes about 25% of all the Sr-90 leaving Oak Ridge National Laboratory. Seep C was identified as a primary source of off-site contaminant transport and was designated for an early removal action under the Comprehensive Environmental Response and Liability Act (CERCLA). A passive-flow treatment system was chosen as the most cost-effective method for treating the seep water. The goal of the removal action is to have a system operational by November 1, 1994, that reduces the Sr-90 concentration in the water collected and treated by at least 90%. In order to provide design and operating data for the full-scale system, a pilot-scale system, consisting of a 5-gal bucket with an inlet connection in the lid and a screened outlet on the bottom filled with 16 L of chabazite zeolite, was used to treat the seep water. The test was started on March 17, 1994, and concluded on June 15, 1994. The system treated 63,470 L (3967 bed volumes) of water and 22.7 mCi of Sr-90 from the seep water. The system removed over 99.5% of the Sr-90 from the first 43,000 L of water treated, after which the removal efficiency slowly decreased as the zeolite became loaded until it reached 84% for the final sample. The passive system performed at least as well as comparable pumped zeolite systems in terms of removal efficiency and zeolite utilization. The test was terminated just before the construction crew mobilized at Seep C to build the full-scale system.

5422 (ORNL/ER–268) **Data management implementation plan for the site characterization of the Waste Area Grouping 1 Groundwater Operable Unit at Oak Ridge National Laboratory.** Ball, T.S.; Nickle, E.B. Oak Ridge National Lab., TN (United States). Oct 1994. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003902. Source: OSTI; NTIS; INIS; GPO Dep.

The Waste Area Grouping (WAG) 1 Groundwater Operable Unit (OU) at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, is undergoing a site characterization. This project is not mandated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); therefore, no formalized meetings for data quality objective (DQO) development were held. Internally, DQOs were generated by the project team based on the end uses of the data to be collected. The 150-acre WAG 1 is contained within the ORNL security area. It includes all of the former ORNL radioisotope research, production, and maintenance facilities; former waste management areas; and some former administrative facilities. The goal of the WAG 1 Groundwater Site Characterization is to provide the necessary data on the nature and extent of groundwater contamination with an acceptable level of uncertainty to support the selection of remedial alternatives and to identify additional data needs for future actions. Primary objectives for the site characterization are: (1) To identify and characterize contaminant migration pathways based on the collection of groundwater data; (2) to identify sources of groundwater contamination and evaluate remedial actions which could be implemented to control or eliminate these sources; and (3) To conduct groundwater monitoring in support of other OUs in WAG 1 and the ORNL Groundwater OU.

5423 (ORNL/ER–269) **Hydrologic data summary for the White Oak Creek watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee (January–December 1993).** Borders, D.M. (Univ. of Tennessee, Knoxville, TN (United States). Dept. of Civil Engineering); Frederick, B.J.; Reece, D.K.; McCalla, W.L.; Watts, J.A.; Ziegler, K.S. Oak Ridge National Lab., TN (United States). Environmental Sciences Div. Oct 1994. 129p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003971. Source: OSTI; NTIS; INIS; GPO Dep. ESD Publication 4293.

This report summarizes, for the 12-month period (January through December 1993), the available dynamic hydrologic data collected, primarily, on the White Oak Creek (WOC) watershed along with information collected on the surface flow systems which affect the quality or quantity of surface water. Identification of spatial and temporal trends in hydrologic parameters and mechanisms that affect the movement of contaminants supports the development of interim corrective measures and remedial restoration alternatives. In addition, hydrologic monitoring supports long-term assessment of the effectiveness of remedial actions in limiting the transport of contaminants across Waste Area Grouping (WAG) boundaries and ultimately to the off-site environment. For these reasons, it is of paramount importance to the Environmental Restoration Program (ERP) to collect and report hydrologic data, an activity that contributes to the Site Investigations (SI) component of the ERP. This report provides and describes sources of hydrologic data for Environmental Restoration activities that use monitoring data to quantify and assess the impact from releases of contaminants from ORNL WAGs.

5424 (ORNL/ER–282) **FY 1994 annual summary report of the surveillance and maintenance activities for the Oak Ridge National Laboratory Environmental Restoration Program.** Oak

Ridge National Lab., TN (United States); Stoller (S.M.) Corp., Oak Ridge, TN (United States). Nov 1994. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003970. Source: OSTI; NTIS; INIS; GPO Dep.

The Oak Ridge National Laboratory (ORNL) Environmental Restoration (ER) Surveillance and Maintenance (S and M) Program was initiated to manage former waste management and environmental research sites contaminated with radioactive materials and/or hazardous chemicals. The S and M Program is responsible for managing designated sites/facilities from the end of their operating lives until final disposition or site stabilization. To effectively manage and perform the various S and M Program responsibilities, five summary-level work breakdown structure (WBS) elements have been established: S and M Preliminary Investigations, Special Projects, Routine S and M, Inactive Groundwater Wells, and Project Management. Routine S and M activities were conducted as scheduled throughout fiscal years (FY) 1994 at applicable inactive waste management (WM) and other contaminated areas. Overall, the ER S and M Program maintains 47 facilities, performs vegetation maintenance on approximately 230 acres, maintains 54 inactive tanks, and provides overall site management on over 700 acres. In addition to the routine S and M activities, detailed site inspections were conducted at established frequencies on appropriate sites in the ER S and M Program. This document provides a summary of the FY 1994 ORNL ER S and M Program accomplishments.

5425 (ORNL/ER–283) **Removal action work plan for Corehole 8 in Waste Area Grouping 1 at Oak Ridge National Laboratory, Oak Ridge, Tennessee.** Oak Ridge National Lab., TN (United States); Foster-Wheeler Environmental Corp., Oak Ridge, TN (United States). Nov 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003968. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of the Waste Area Grouping 1 Corehole 8 Removal Action is to collect strontium-90 contaminated groundwater that is currently being discharged from existing storm drains into First Creek. ^{90}Sr has been identified as a major contributor to potential risk offsite. First Creek contributes about 10% of the ^{90}Sr contamination detected at White Oak Dam. This Removal Action Work Plan (RAWP) addresses construction of new french drains, gravity piping, and a pressure sewer pipeline to collect and pump the contaminated water to Manhole 24. The contaminated water will then flow through existing pipes to the Process Waste Treatment Plant for treatment. The proposed scope of work for this project includes the installation of approximately 480 ft of high-density polyethylene gravity piping, with cleanouts, to transport the contaminated water to a proposed pumping station. The contaminated water will then be pumped from the new pump station approximately 1,140 ft through a new force main to Manhole 24. This project will reduce the quantity of ^{90}Sr contaminated groundwater entering First Creek.

5426 (ORNL/PATS–94-004) **Packaging- and transportation-related occurrence reports: July–September 1994.** Welch, M.J.; Dickerson, L.S.; Jennings, S.D. Oak Ridge National Lab., TN (United States). Nov 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003993. Source: OSTI; NTIS; GPO Dep.

The Packaging and Transportation Safety Program (PATS), which is sponsored by the Office of Environment, Safety and Health, Transportation and Packaging Safety Division, EH-332, has been charged with the responsibility of retrieving reports and information pertaining to transportation or packaging incidents or accidents from the Occurrence Reporting and Processing System (ORPS). These selected reports are being analyzed for trends, impact on EH-332 policies and concerns, and lessons learned concerning transportation and packaging safety. This task is designed not only to keep EH-332 aware of current packaging and transportation incidents and potential transportation and packaging problems that may need attention on DOE sites, but also it is intended to allow future dissemination of lessons learned to the Operations Offices and, subsequently, to management and operating contractors. This report summarizes 12 weekly reports which contain a total of 50 occurrence reports (ORs) relating to packaging and transportation issues. Five reports are highlighted. These concerned employees involvement in a commercial airline crash, the number of bolts needed for spent fuel casks, the shipment of a device classified as Secret Restricted Data by a commercial carrier in an unsecured configuration, entangling of electrical power lines, and a bulging plutonium storage can.

5427 (ORNL/TM–12250) **Methodology to remediate a mixed waste site.** Berry, J.B. Oak Ridge National Lab., TN (United States). Aug 1994. 191p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95004221. Source: OSTI; NTIS; INIS; GPO Dep.

In response to the need for a comprehensive and consistent approach to the complex issue of mixed waste management, a generalized methodology for remediation of a mixed waste site has been developed. The methodology is based on requirements set forth in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) and incorporates "lessons learned" from process design, remediation methodologies, and remediation projects. The methodology is applied to the treatment of 32,000 drums of mixed waste sludge at the Oak Ridge K-25 Site. Process technology options are developed and evaluated, first with regard to meeting system requirements and then with regard to CERCLA performance criteria. The following process technology options are investigated: (1) no action, (2) separation of hazardous and radioactive species, (3) dewatering, (4) drying, and (5) solidification/stabilization. The first two options were eliminated from detailed consideration because they did not meet the system requirements. A quantitative evaluation clearly showed that, based on system constraints and project objectives, either dewatering or drying the mixed waste sludge was superior to the solidification/stabilization process option. The ultimate choice between the drying and the dewatering options will be made on the basis of a technical evaluation of the relative merits of proposals submitted by potential subcontractors.

5428 (PNL–9998) **Imaging through obscurations for sluicing operations in the waste storage tanks.** Peters, T.J.; McMakin, D.L.; Sheen, D.M.; Chieda, M.A. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 86p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94017780. Source: OSTI; NTIS; INIS; GPO Dep.

Waste remediators have identified that surveillance of waste remediation operations and periodic inspections of stored waste are required under very demanding and difficult viewing environments. In many cases, obscurants such as dust or water vapor are generated as part of the remediation activity. Methods are required for viewing or imaging beyond the normal visual spectrum. Work space images guide the movement of remediation equipment, creating a need for rapidly updated, near real-time imaging capability. In addition, there is a need for three-dimensional topographical data to determine the contours of the wastes, to plan retrieval campaigns, and to provide a three-dimensional map of a robot's work space as basis for collision avoidance. Three basic imaging techniques were evaluated: optical, acoustic and radar. The optical imaging methods that were examined used cameras which operated in the visible region and near-infrared region and infrared cameras which operated in the 3–5 micron and 8–12 micron wavelength regions. Various passive and active lighting schemes were tested, as well as the use of filters to eliminate reflection in the visible region. Image enhancement software was used to extend the range where visual techniques could be used. In addition, the operation of a laser range finder, which operated at 0.835 microns, was tested when fog/water droplets were suspended in the air. The acoustic technique involved using commercial acoustic sensors, operating at approximately 50 kHz and 215 kHz, to determine the attenuation of the acoustic beam in a high-humidity environment. The radar imaging methods involved performing millimeter wave (94 GHz) attenuation measurement sin the various simulated sluicing environments and performing preliminary experimental imaging studies using a W-Band (75–110 GHz) linearly scanned transceiver in a laboratory environment. The results of the tests are discussed.

5429 (PNL–10060) **Identification of radionuclides of concern in Hanford Site environmental cleanup.** Perkins, R.W.; Jenquin, U.P. Pacific Northwest Lab., Richland, WA (United

States). Aug 1994. 104p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004387. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to consider which radionuclides should be included in conducting environmental surveys relative to site remediation at Hanford. During the operation of the Hanford site, the fission product radionuclides and a large number of activation products including the transuranic radionuclides were formed. The reactor operations and subsequent chemical processing and metallurgical operations resulted in the environmental release of gaseous and liquid effluents containing some radionuclides; however, the majority of the radionuclides were stored in waste tanks or disposed to trenches and cribs. Since some contamination of both soils and subsurface waters occurred, one must decide which radionuclides still remain in sufficient amounts to be of concern at the time when site remediation is to be complete. Many of the radionuclides which have constituted the principal hazard during site operation have half-lives on the order of a year or less; therefore, they will have decayed to insignificant amounts by the year 2030, a possible date for completion of the remediation process.

5430 (PNL-SA-23411) **A DOE manual: DOE methods for evaluating environmental and waste management samples.** Goheen, S.C.; Fadeff, S.K.; Sklarew, D.S.; McCulloch, M.; Mong, G.M.; Riley, R.G.; Thomas, B.L. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-940815--79: International nuclear and hazardous waste management conference, Atlanta, GA (United States), 14-18 Aug 1994). Order Number DE94017476. Source: OSTI; NTIS; INIS; GPO Dep.

DOE Methods for Evaluating Environmental and Waste Management Samples (DOE Methods) is a guidance/methods document supporting environmental restoration (ER) and waste management (WM) (collectively referred to as EM) sampling and analysis activities at US Department of Energy (DOE) sites. DOE Methods is intended to supplement existing guidance documents (e.g., the US Environmental Protection Agency's Test Methods for Evaluating Solid Waste, SW-846), which apply to low-level or non-radioactive samples, and the complexities of waste and environmental samples encountered at DOE sites. The document contains quality assurance (QA), quality control (QC), safety, sampling, organic analysis, inorganic analysis, and radio-analytical guidance as well as sampling and analytical methods. It is updated every six months (April and October) with additional methods. As of April 1994, DOE methods contained 3 sampling and 39 analytical methods. It is anticipated that between 10 and 20 new methods will be added in October 1994. All methods are either peer reviewed and contain performance data, or are included as draft methods.

5431 (PNL-SA-24403) **In situ remediation: Developing containment technologies.** Peterson, M. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-940815--83: International nuclear and hazardous waste management conference, Atlanta, GA (United States), 14-18 Aug 1994). Order Number DE94017479. Source: OSTI; NTIS; INIS; GPO Dep.

The In Situ Remediation Integrated Program (ISR IP) was established by the US Department of Energy's (DOE) Office of Technology Development (OTD) to advance the state-of-the art of innovative in situ remediation technologies to the point of demonstration, and to broaden the applicability of these technologies to the widely varying site remediation requirements throughout the DOE complex. This program complements ongoing demonstration programs being conducted at several DOE sites. The ISR-IP has been conducting baseline assessments of in situ technologies to support program planning. One of the assessments has focused on evaluating subsurface containment barrier technologies to identify the current state-of-the-art and determine R and D requirements to enable the deployment of these technologies. DOE's needs are mostly driven by issues concerning the large number of sites requiring remediation, the wide variation among the sites themselves, and the broad range of contaminants at these sites. Many of the sites contain a mixture of organic and inorganic hazardous waste and radioactive waste in a variety of media. Current remedial action strategies for hazardous waste sites are considering containment mostly as an interim action to prevent migration of contaminants from the site until a Record of Decision is made. In some cases, containment is also considered as a remedial action alternative where it is determined to be the best compromise between cost and effectiveness over a relatively short period of time (about 30 years).

5432 (RFP-ENV-93) **Rocky Flats Plant Site Environmental Report: 1993 Highlights.** EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant. [1993]. 387p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC34-90DP62349. Order Number DE94018599. Source: OSTI; NTIS; INIS; GPO Dep.

The Rocky Flats Plant Site Environmental Report provides summary information on the plant's environmental monitoring programs and the results recorded during 1993. The report contains a compliance summary, results of environmental monitoring and other related programs, a review of environmental remediation activities, information on external gamma radiation dose monitoring, and radiation dose estimates for the surrounding population. This section provides an overview of these topics and summarizes more comprehensive discussions found in the main text of this annual report.

5433 (SAND-94-2394C) **The accident site portable integrated video system.** Jones, D.P.; Shirey, D.L.; Amai, W.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950232--2: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95000539. Source: OSTI; NTIS; GPO Dep.

This paper presents a high bandwidth fiber-optic communication system intended for post accident recovery of weapons. The system provides bi-directional multichannel, and multi-media communications. Two smaller systems that were developed as direct spin-offs of the larger system are also briefly discussed.

5434 (UCRL-JC-115345) **Dynamic Underground Stripping: In situ steam sweeping and electrical heating to remediate a deep hydrocarbon spill.** Yow, J.L. Jr.; Aines, R.D.; Newmark, R.L.; Udell, K.S.; Ziagos, J.P. Lawrence Livermore National Lab., CA (United States). Jul 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950225--1: Geoenvironment 2000 meeting, Baton Rouge, LA (United States), 22-24 Feb 1995). Order Number DE94016595. Source: OSTI; NTIS; GPO Dep.

Dynamic Underground Stripping is a combination of in situ steam injection, electrical resistance heating, and fluid extraction for rapid removal and recovery of subsurface contaminants such as solvents or fuels. Underground imaging and other measurement techniques monitor the system in situ for process control. Field tests at a deep gasoline spill at Lawrence Livermore National Laboratory recovered over 7000 gallons of gasoline during several months of field operations. Preliminary analysis of system cost and performance indicate that Dynamic Underground Stripping compares favorably with conventional pump-and-treat and vacuum extraction schemes for removing non-aqueous phase liquids such as gasoline from deep subsurface plumes.

5435 (UCRL-JC-117489) **Seismic design and evaluation criteria based on target performance goals.** Murray, R.C. (Lawrence Livermore National Lab., CA (United States)); Nelson, T.A.; Kennedy, R.P.; Short, S.A. Lawrence Livermore National Lab., CA (United States). Apr 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940613--25: 1994 pressure vessels and piping conference, Minneapolis, MN (United States), 19-23 Jun 1994). Order Number DE94017309. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy utilizes deterministic seismic design/evaluation criteria developed to achieve probabilistic performance goals. These seismic design and evaluation criteria are intended to apply equally to the design of new facilities and to the evaluation of

existing facilities. In addition, the criteria are intended to cover design and evaluation of buildings, equipment, piping, and other structures. Four separate sets of seismic design/evaluation criteria have been presented each with a different performance goal. In all these criteria, earthquake loading is selected from seismic hazard curves on a probabilistic basis but seismic response evaluation methods and acceptable behavior limits are deterministic approaches with which design engineers are familiar. For analytical evaluations, conservatism has been introduced through the use of conservative inelastic demand-capacity ratios combined with ductile detailing requirements, through the use of minimum specified material strengths and conservative code capacity equations, and through the use of a seismic scale factor. For evaluation by testing or by experience data, conservatism has been introduced through the use of an increase scale factor which is applied to the prescribed design/evaluation input motion.

5436 (WHC-EP–0474-14) **Quarterly report on the Ferrocyanide Safety Program for the period ending September 30, 1994.** Meacham, J.E.; Cash, R.J.; Dukelow, G.T. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 75p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003267. Source: OSTI; NTIS; GPO Dep.

This is the fourteenth quarterly report on the progress of activities addressing the Ferrocyanide Safety Issue associated with Hanford Site high-level radioactive waste tanks. Progress in the Ferrocyanide Safety Program is reviewed, including work addressing the six parts of Defense Nuclear Facilities Safety Board Recommendation 90-7 (FR 1990). All work activities are described in the revised program plan, and this report follows the same format presented there. A summary of the key events occurring this quarter is presented in Section 1.2. More detailed discussions of progress are located in Sections 3.0 and 4.0.

5437 (WHC-EP–0779-Draft) **Architecture synthesis basis for the Hanford Cleanup system: First issue.** Holmes, J.J. (comp.). Westinghouse Hanford Co., Richland, WA (United States). Jun 1994. 96p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94018003. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes a set of candidate alternatives proposed to accomplish the Hanford Cleanup system functions defined in a previous work. Development of alternatives is part of a sequence of system engineering activities which lead to definition of all the products which, when completed, accomplish the cleanup mission. The alternative set is developed to functional level four or higher depending on need.

5438 (WHC-EP–0801-Draft) **Systems engineering product breakdown structure for the Hanford Cleanup Mission: First issue.** Holmes, J.J. (Westinghouse Hanford Co., Richland, WA (United States)); Bailey, K.B.; Collings, J.L.; Hubbard, A.B.; Niepke, T.M. Westinghouse Hanford Co., Richland, WA (United States). Aug 1994. 87p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001579. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the product breakdown structure (PBS) for the upper level physical products that, when delivered, complete the Hanford Site Cleanup Mission. Development of the PBS is a continuation of the sitewide systems engineering work described in the sitewide functional analysis, the architecture synthesis, and the product description report and is generally consistent with guidance contained in the Hanford Mission Plan. The PBS presents the interrelationship of products produced by the functions that are necessary to perform the clean up mission from their initial source through interim products to final product disposition.

5439 (WHC-SD-631-ATP–006) **Fire alarm system improvement.** Hodge, S.G. Westinghouse Hanford Co., Richland, WA (United States). Oct 1994. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003247. Source: OSTI; NTIS; INIS; GPO Dep.

This document contains the Fire Alarm System Test Procedure for Building 234-5Z, 200-West Area on the Hanford Reservation, Richland, Washington. This Acceptance Test Procedure (ATP) has been prepared to demonstrate that the modifications to the Fire Protection systems function as required by project criteria. The ATP will test the Fire Alarm Control Panels, Flow Alarm Pressure Switch, Heat Detectors, Smoke Detectors, Flow Switches, Manual Pull Stations, and Gong/Door by Pass Switches.

5440 (WHC-SD-CP-RD–022-Rev.1) **Bases for PUREX deactivation safety equipment list.** Walser, R.L. Westinghouse Hanford Co., Richland, WA (United States). 21 Nov 1994. 119p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004431. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the basis and justification for changes in classification of equipment listed in WHC-SD-SEL-001 Rev 1, "PUREX Plant Safety Equipment List." The reference document will be re-issued as Rev 2 based on the DEACTIVATION mode as evaluated in this document. Systems, components, and structures are evaluated based on consequences of failure on the health and safety of the general public for Safety Class 1, the health and safety of the on-site worker for Safety Class 2, and the health and safety of the facility worker for Safety Class 3. The consequences of a failure on the environment are also addressed in this ranking based on the level of insult. The criteria for the three levels of Safety class equipment are given in Appendix I for ease of reference.

5441 (WHC-SD-CP-WP–023) **Engineering work plan for PFP criticality alarm panel first unit re-build.** Clem, W.E. Westinghouse Hanford Co., Richland, WA (United States). 14 Sep 1994. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001303. Source: OSTI; NTIS; INIS; GPO Dep.

This document describes the first step in increasing the quality, reliability, and ease of maintenance of the nine Criticality Alarm Panels (CAP) at PFP. Development control practices and guidelines of WHC-CM-6-1, EP-2.4 and WHC-IP-1026, EPG-2.4 are applied to develop a prototype of a replacement Criticality Alarm Panel (CAP) with facility-use potential. During the development of the prototype CAP, the design requirements of all of PFP's nine CAPs are considered to develop standardized hardware and detailed design drawings that are tailored to PFP maintenance needs. Increased quality and reliability is achieved through quality hardware, proven technology and design techniques, and the use of the Class 1E workmanship standards of WHC-CM-8-1. The end result of the work described by this work plan is a verified/read-to-install replacement for CAP Z4 and verified/released H-2 drawings that are formatted such that they can easily be replicated when producing design drawings for the other eight CAPs.

5442 (WHC-SD-EN-TP–047-Rev.1) **Integrated test plan ResonantSonic drilling system technology demonstration-1995, at the Hanford Site: Revision 1.** McLellan, G.W. Westinghouse Hanford Co., Richland, WA (United States). 17 Nov 1994. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004148. Source: OSTI; NTIS; INIS; GPO Dep.

This integrated test plan describes the demonstration test of the ResonantSonic drilling system. This demonstration is part of the Office of Technology Development's Volatile Organic Compound Arid Integrated Demonstration (VOC-Arid ID). Two main purposes of this demonstration are (1) to continue testing the ResonantSonic drilling system compatibility with the Hanford Site waste characterization programs, and (2) to transfer this method for use at the Hanford Site, other government sites, and the private sector. The ResonantSonic method is a dry drilling technique. Field testing of this method began in July 1993. During the next four months, nine holes were drilled, and continuous core samples were retrieved. Penetration rates were 2 to 3 times the baseline, and the operational downtime rate was less than 10%. Successfully demonstrated equipment refinements included a prototype 300 series ResonantSonic head, a new drill rod design for 18-centimeter diameter pipe, and an automated pipe handling system. Various configurations of sampling equipment and drill bits were tested, depending on geologic conditions. The principal objective of the VOC-Arid ID is to determine the viability of emerging technologies that can be used to characterize, remediate, and/or monitor arid or

semiarid sites containing VOCs (e.g., carbon tetrachloride) with or without associated metal and radionuclide contamination.

5443 (WHC-SD-ER-TC–001) **Laboratory procedures for waste form testing.** Mast, E.S. Westinghouse Hanford Co., Richland, WA (United States). 19 Sep 1994. 49p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001562. Source: OSTI; NTIS; INIS; GPO Dep.

The 100 and 300 areas of the Hanford Site are included on the US Environmental Protection Agencies (EPA) National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Soil washing is a treatment process that is being considered for the remediation of the soil in these areas. Contaminated soil washing fines can be mixed or blended with cementations materials to produce stable waste forms that can be used for beneficial purposes in mixed or low-level waste landfills, burial trenches, environmental restoration sites, and other applications. This process has been termed co-disposal. The Co-Disposal Treatability Study Test Plan is designed to identify a range of cement-based formulations that could be used in disposal efforts in Hanford in co-disposal applications. The purpose of this document is to provide explicit procedural information for the testing of co-disposal formulations. This plan also provides a discussion of laboratory safety and quality assurance necessary to ensure safe, reproducible testing in the laboratory.

5444 (WHC-SD-GN-ATP–20003) **RFAR installation for Buildings 703, 712, 747, 748 and 1163.** Ferry, M. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004156. Source: OSTI; NTIS; INIS; GPO Dep.

This document is to certify the installation and testing of the Radio Fire Alarm Reporting box (RFAR). The Hanford Fire Dept. will be notified of troubles via RFAR. The document outlines prerequisites, necessary equipment, and the fire alarm system test to insure the system is operating correctly.

5445 (WHC-SD-PRP-HA–013) **Tank farms hazards assessment.** Broz, R.E. Westinghouse Hanford Co., Richland, WA (United States). 30 Sep 1994. 76p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001581. Source: OSTI; NTIS; INIS; GPO Dep.

Hanford contractors are writing new facility specific emergency procedures in response to new and revised US Department of Energy (DOE) Orders on emergency preparedness. Emergency procedures are required for each Hanford facility that has the potential to exceed the criteria for the lowest level emergency, an Alert. The set includes: (1) a facility specific procedure on Recognition and Classification of Emergencies, (2) area procedures on Initial Emergency Response and, (3) an area procedure on Protective Action Guidance. The first steps in developing these procedures are to identify the hazards at each facility, identify the conditions that could release the hazardous material, and calculate the consequences of the releases. These steps are called a Hazards Assessment. The final product is a document that is similar in some respects to a Safety Analysis Report (SAR). The document could br produced in a month for a simple facility but could take much longer for a complex facility. Hanford has both types of facilities. A strategy has been adopted to permit completion of the first version of the new emergency procedures before all the facility hazards Assessments are complete. The procedures will initially be based on input from a task group for each facility. This strategy will but improved emergency procedures in place sooner and therefore enhance Hanford emergency preparedness. The purpose of this document is to summarize the applicable information contained within the Waste Tank Facility "Interim Safety Basis Document, WHC-SD-WM-ISB-001" as a resource, since the SARs covering Waste Tank Operations are not current in all cases. This hazards assessment serves to collect, organize, document and present the information utilized during the determination process.

5446 (WHC-SD-SNF-SARR–001) **Review of consequences of uranium hydride formation in N-Reactor fuel elements stored in the K-Basins.** Weber, J.W. Westinghouse Hanford Co., Richland, WA (United States). 28 Sep 1994. 66p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001593. Source: OSTI; NTIS; INIS; GPO Dep.

The 105-K Basins on the Hanford site are used to store uranium fuel elements and assemblies irradiated in and discharged from N Reactor. The storage cylinders in KW Basin are known to have some broken N reactor fuel elements in which the exposed uranium is slowly reacting chemically with water in the cylinder. The products of these reactions are uranium oxide, hydrogen, and potentially some uranium hydride. The purpose of this report is to document the results f the latest review of potential, but highly unlikely accidents postulated to occur as closed cylinders containing N reactor fuel assemblies are opened under water in the KW basin and as a fuel assembly is raised from the basin in a shipping cask for transportation to the 327 Building for examination as part of the SNF Characterization Program. The postulated accidents reviews in this report are considered to bound all potential releases of radioactivity and hydrogen. These postulated accidents are: (1) opening and refill of a cylinder containing significant amounts of hydrogen and uranium hydride; and (2) draining of the single element can be used to keep the fuel element submerged in water after the cask containing the can and element is lifted from the KW Basin. Analysis shows the release of radioactivity to the site boundary is significantly less than that allowed by the K Basin Safety Evaluation. Analysis further shows there would be no damage to the K Basin structure nor would there be injury to personnel for credible events.

5447 (WHC-SD-T100-CDR–001) **Conceptual design report, Hazardous Materials Management and Emergency Response (HAMMER) Training Center.** Kelly, K.E. (Westinghouse Hanford Co., Richland, WA (United States)). Westinghouse Hanford Co., Richland, WA (United States); Montgomery Watson, Richland, WA (United States). 9 Nov 1994. 398p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003852. Source: OSTI; NTIS; INIS; GPO Dep.

For the next 30 years, the main activities at the US Department of Energy (DOE) Hanford Site will involve the management, handling, and cleanup of toxic substances. If the DOE is to meet its high standards of safety, the thousands of workers involved in these activities will need systematic training appropriate to their tasks and the risks associated with these tasks. Furthermore, emergency response for DOE shipments is the primary responsibility of state, tribal, and local governments. A collaborative training initiative with the DOE will strengthen emergency response at the Hanford Site and within the regional communities. Local and international labor has joined the Hazardous Materials Management and Emergency Response (HAMMER) partnership, and will share in the HAMMER Training Center core programs and facilities using their own specialized trainers and training programs. The HAMMER Training Center will provide a centralized regional site dedicated to the training of hazardous material, emergency response, and fire fighting personnel.

5448 (WHC-SD-T100-PLN–001) **Project plan, Hazardous Materials Management and Emergency Response Training Center: Project 95L-EWT-100.** Borgeson, M.E. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003850. Source: OSTI; NTIS; INIS; GPO Dep.

The Hazardous Materials Management and Emergency Response (HAMMER) Training Center will provide for classroom lectures and hands-on practical training in realistic situations for workers and emergency responders who are tasked with handling and cleanup of toxic substances. The primary objective of the HAMMER project is to provide hands-on training and classroom facilities for hazardous material workers and emergency responders. This project will also contribute towards complying with the planning and training provisions of recent legislation. In March 1989 Title 29 Code of Federal Regulations Occupational Safety and Health Administration 1910 Rules and National Fire Protection

Association Standard 472 defined professional requirements for responders to hazardous materials incidents. Two general types of training are addressed for hazardous materials: training for hazardous waste site workers and managers, and training for emergency response organizations.

5449 (WHC-SD-T100-QAPP–001) **Project T100 – Hazardous Materials Management and Emergency Response Training Center (HAMMER).** Norton, C.E. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003772. Source: OSTI; NTIS; INIS; GPO Dep.

The scope of this Quality Assurance Program Plan (QAPP) is to provide a system of Quality Assurance reviews and verifications on the design and construction of the Hazardous Materials Management and Emergency Response (HAMMER) Training Center, project 95L-EWT-100 at Hanford. The reviews and verifications will be on activities associated with design, procurement, and construction of the HAMMER project which includes, but is not limited to earthwork, placement of concrete, laying of rail, drilling of wells, water and sewer line fabrication and installation, communications systems, fire protection/detection systems, line tie-ins, building and mock-up (prop) construction, electrical, instrumentation, pump and valves and special coatings.

5450 (WHC-SD-W-113-OCD–001) **Solid waste retrieval. Phase 1, Operational basis.** Johnson, D.M. Westinghouse Hanford Co., Richland, WA (United States). 30 Sep 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001533. Source: OSTI; NTIS; INIS; GPO Dep.

This Document describes the operational requirements, procedures, and options for execution of the retrieval of the waste containers placed in buried storage in Burial Ground 218W-4C, Trench 04 as TRU waste or suspect TRU waste under the activity levels defining this waste in effect at the time of placement. Trench 04 in Burial Ground 218W-4C is totally dedicated to storage of retrievable TRU waste containers or retrievable suspect TRU waste containers and has not been used for any other purpose.

5451 (WHC-SD-W340-SEL–002) **Preliminary safety equipment list for Tank 241-C-106 Manipulator Retrieval System, Project W-340.** Guthrie, R.L. Westinghouse Hanford Co., Richland, WA (United States). 23 Sep 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95000987. Source: OSTI; NTIS; INIS; GPO Dep.

This document identifies the anticipated safety classification of the estimated major subsystems, based on the projected major functions, that will be used as guidance for the development of the conceptual design of the Manipulator Retrieval System for Tank 241-C-106. This document is intended to be updated as the design of the Manipulator Retrieval System evolves through the conceptual and definitive design phases. The Manipulator Retrieval System is to be capable of removing the hardened sludge heel at the bottom of single shell Tank 241-C-106 and to perform an overall clean out of the tank that leaves a maximum of 360 ft^3 (TPA milestone M-45-00). The thickness of the heel prior to initiation of waste retrieval with the Manipulator Retrieval System is estimated to be 1- to 2-ft. The Manipulator Retrieval System is currently in the pre-conceptual phase with no definitive systems or subsystems. The anticipated retrieval functions for the Manipulator Retrieval System is based on Table 6-2 of WHC-SD-W340-ES-001, Rev. 1. Projected equipment to accomplish these functions were based on the following systems and equipment: Rotary Mode Core Sampling Equipment (WHC-SD-WM-SEL-032); Light Duty Utility Arm System Equipment (WHC-SD-WM-SEL-034); Single Shell Tanks Equipment (WHC-SD-WM-SEL-020).

5452 (WHC-SD-WM-ATP–114) **2707SX FACP replacement.** Ferry, M.F. Westinghouse Hanford Co., Richland, WA (United States). 17 Nov 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004159. Source: OSTI; NTIS; INIS; GPO Dep.

This Acceptance Test Procedure (ATP) has been prepared to demonstrate that the Fire Protection system functions as required by project criteria. This ATP will test the Pyrotronic CP-400 fire alarm control panel (FACP), and interfaces with the radio fire alarm reporting box, alarm/supervisory initiating devices, and alarm indicating appliances. This document is to certify the installation of the fire alarm control panel and all attached devices to insure the Hanford Fire Dept. receives the proper signals. This particular fire alarm control panel services Bldg. 2707SX in the 200W Area of Hanford.

5453 (WHC-SD-WM-ATP–115) **242T FACP replacement.** Ferry, M.F. Westinghouse Hanford Co., Richland, WA (United States). 17 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004155. Source: OSTI; NTIS; INIS; GPO Dep.

This Acceptance Test Procedure (ATP) has been prepared to demonstrate that the Fire Protection system functions as required by project criteria. This ATP will test the Pyrotronic CP-400 fire alarm control panel (FACP), and interfaces with the radio fire alarm reporting box, alarm/supervisory initiating devices, and alarm indicating appliances. This document is to certify the installation and testing of the fire alarm control panel and all attached devices to insure the Hanford Fire Dept. receives the proper signals. This fire alarm control panel is located in Bldg. 242T in the 200 W Area of Hanford.

5454 (WHC-SD-WM-CSDD–004) **The family of standard hydrogen monitoring system computer software design description: Revision 2.** Bender, R.M. Westinghouse Hanford Co., Richland, WA (United States). 16 Nov 1994. 56p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003780. Source: OSTI; NTIS; INIS; GPO Dep.

In March 1990, 23 waste tanks at the Hanford Nuclear Reservation were identified as having the potential for the buildup of gas to a flammable or explosive level. As a result of the potential for hydrogen gas buildup, a project was initiated to design a standard hydrogen monitoring system (SHMS) for use at any waste tank to analyze gas samples for hydrogen content. Since it was originally deployed three years ago, two variations of the original system have been developed: the SHMS-B and SHMS-C. All three are currently in operation at the tank farms and will be discussed in this document. To avoid confusion in this document, when a feature is common to all three of the SHMS variants, it will be referred to as "The family of SHMS." When it is specific to only one or two, they will be identified. The purpose of this computer software design document is to provide the following: the computer software requirements specification that documents the essential requirements of the computer software and its external interfaces; the computer software design description; the computer software user documentation for using and maintaining the computer software and any dedicated hardware; and the requirements for computer software design verification and validation.

5455 (WHC-SD-WM-DA–177) **Structural integrity analysis of the 224U elevator mothballing.** Boehnke, W.M. Westinghouse Hanford Co., Richland, WA (United States). 18 Nov 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003998. Source: OSTI; NTIS; INIS; GPO Dep.

As part of the preparation of Building 224U for turnover to Decontamination and Decommissioning, it is necessary to place the elevator in a mothballed condition so that it can be reactivated for use after 10 to 25 years. This mothballing is going to be accomplished by landing the counterweight on wooden timbers and suspending the elevator cab with wire rope or chain slings. This will take the load off the cables and make it relatively easy to reactive. The objective of this Supporting Document is to verify the structural integrity of all of the load bearing components involved in mothballing the 224U Building elevator. Building 224U is part of the UO_3 Plant where uranyl nitrates from the PUREX Plant was converted to UO_3 powder.

5456 (WHC-SD-WM-ER–393) **Seismic qualification of a switch box.** Miller, S.M. Westinghouse Hanford Co., Richland, WA (United States). 23 Nov 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004365. Source: OSTI; NTIS; INIS; GPO Dep.

This supporting document details the results of a seismic analysis on a switch box assembly. The switch box is mounted to a Unistrut frame and is attached to the concrete floor in the 225B Building with Hilti Kwik bolts. The assembly was found to meet safety class 3 requirement. Although all components analyzed were found to be structurally adequate, some changes are recommended. To comply with SDC 4.2 specification, the Hilti Kwik bolts should be: placed at least 8 1/4 inches from the edge of the concrete floor; should have a minimum spacing of 8 inches from any Kwik bolt; and should be embedded 5 1/2 inches into the concrete. The minimum embedment distance is 2 3/4 inches. Furthermore, when the bolts are installed, rebar within the concrete should not be cut or damaged. Finally, the length of the Hilti Kwik bolt should be sized such that the distance from the top of the bolt to the top of the nut is not less than 2 thread pitches, and not more that 3/4 inch.

5457 (WHC-SD-WM-ES–311) **Tri-Party Agreement Milestone M-45-07A; complete evaluation of subsurface barrier feasibility: Summary report.** Cox, G.E. (Enserch Environmental Corp., Richland, WA (United States)); Peters, B.B.; Treat, R.L.; Bazinet, G.D.; Cruse, J.M.; Hampsten, K.L. Westinghouse Hanford Co., Richland, WA (United States). Sep 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001512. Source: OSTI; NTIS; INIS; GPO Dep.

The US Department of Energy (DOE) has established the Tank Waste Remediation System (TWRS) program to safely manage and dispose the low-level and high-level radioactive and hazardous wastes currently held in 177 tanks and approximately 1,900 sealed capsules located on the Hanford Site. The remediation of the entire Hanford Site is being conducted under the Hanford Federal Facility Agreement and Consent Order, otherwise known as the Tri-Party Agreement. The three parties that concluded the agreement are the DOE, the US Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology). The purpose of the Tri-Party Agreement is to ensure that Hanford Site activities are performed in a manner that protects the public health, welfare, and the environment. The agreement provides a framework and structure for the many different agencies and regulations under which work is performed on the Site, listing responsibilities and attaching scheduled dates of completion for minimum performances (known as milestones). The Tri-Party Agreement Milestone M-45-07A requires that an assessment of the feasibility of subsurface barriers to support retrieval of tank waste be performed. The activities to meet this milestone have been completed, and are documented herein.

5458 (WHC-SD-WM-SEL–033-Rev.1) **Safety equipment list for 241-C-106 waste retrieval, Project W-320: Revision 1.** Conner, J.C. Westinghouse Hanford Co., Richland, WA (United States). 15 Nov 1994. 364p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004112. Source: OSTI; NTIS; INIS; GPO Dep.

The goals of the C-106 sluicing operation are: (1) to stabilize the tank by reducing the heat load in the tank to less than 42 MJ/hr (40,000 Btu/hour), and (2) to initiate demonstration of single-shell tank (SST) retrieval technology. The purpose of this supporting document (SD) is as follows: (1) to provide safety classifications for items (systems, structures, equipment, components, or parts) for the waste retrieval sluicing system (WRSS), and (2) to document and methodology used to develop safety classifications. Appropriate references are made with regard to use of existing systems, structures, equipments, components, and parts for C-106 single-shell transfer tank located in the C Tank Farm, and 241-AY-102 (AY-102) double shell receiver tanks (DST) located in the Aging Waste Facility (AWF). The Waste Retrieval Sluicing System consists of two transfer lines that would connect the two tanks, one to carry the sluiced waste slurry to AY-102, and the other to return the supernatant liquid to C-106. The supernatant, or alternate fluid, will be used to mobilize waste in C-106 for the sluicing process. The equipment necessary for the WRSS include pumps in each tank, sluicers to direct the supernatant stream in C-106, a slurry distributor in AY-102, HVAC for C-106, instrumentation and control devices, and other existing components as required.

5459 (WHC-SD-WM-TP–263) **Elevated drum testing Phase 1 test plan.** McBeath, R.S.; Meeuwsen, P.V. Westinghouse Hanford Co., Richland, WA (United States). 1 Sep 1994. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001039. Source: OSTI; NTIS; INIS; GPO Dep.

An important part of the Hanford environmental mission is the packaging, transportation, and storage of solid radioactive wastes in metal drums. Presently storage drums are placed four to a wooden pallet with the drums banded to each other. Palletized drums are stacked three units high in pre-engineered steel structures in the 200 Area of the Hanford site. Permitted storage space is expensive to construct, maintain, and operate. Storage capacity is increased if additional drum can be stacked within existing facilities and a cost savings over new construction realized. The purpose of this plan is to outline the testing required to provide the safety criteria for elevated (i.e., tiers of four high) drum storage. The major safety concern with elevated drum storage is the danger of a significant fire in the storage facility. The major fire load within the storage facilities is combustible material contained in the drums. If a seismic event, fork lift accident, or other credible incident were to cause drum failure or lid separation, combustible material could be available for fuel. To increase the initial burn in the facilities, the drums must spill their combustible contents, making them free for ignition. If it can be shown that there is not sufficient damage to the drums to allow for release of their solid contents, then the data used for safety documentation will be re-examined. Preliminary tests conducted in the configurations detailed in this test plan have shown that drums maintain their integrity; that is the drum covers remain attached and the drums do not breach. These tests will be conducted by Westinghouse Hanford Company, Equipment Development organization, who is the designated DOE Center of Excellence to conduct drop tests for Department of Transportation (DOT) certification of DOE designed packages and containers.

5460 (WHC-SD-WM-TPI–016-Rev.2) **Level maintenance for Tank 101-SY mitigation-by-mixing test. Revision 2.** Larsen, D.C. Westinghouse Hanford Co., Richland, WA (United States). 28 Sep 1994. 79p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001410. Source: OSTI; NTIS; INIS; GPO Dep.

The Phase A, Phase B and Full Scale testing portions of the Mitigation-By-Mixing Test have demonstrated the effectiveness of the Mixer Pump to maintain the waste in tank 101-SY in the desired mitigated state. The operation of the 101-SY Mixer Pump for short periods of time results in a controlled release of hydrogen gas in concentrations well below the established safety limits. Additionally, it has been shown that operation of the pump on a regular schedule minimizes the historical generation rate of hydrogen inventory in the waste. Generation of hydrogen inventory is exhibited by waste level growth. The primary objective of this procedure is to maintain the waste level in tank 241-SY-101 within the safe operating range as defined by the Safety Assessment and the Test Plan. The secondary objective is to operate the pump on a schedule that maximizes its useful lifespan and prevents the formation of obstructions in the normal flow path of the pump.

5461 (WHC-SD-WM-WP–285) **TWRS Systems Engineering Working Plan.** Eiholzer, C.R. Westinghouse Hanford Co., Richland, WA (United States). 16 Sep 1994. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001004. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this Systems Engineering (SE) Working Plan (SEWP) is to describe how the Westinghouse Hanford Company (WHC) Tank Waste Remediation System (TWRS) will implement the SE polity and guidance provided in the Tank Waste Remediation System (TWRS) Systems Engineering Management Plan (SEMP). Sections 2.0 through 4.0 cover how the SE process and management will be performed to develop a technical baseline within TWRS. Section 5.0 covers the plans and schedules to implement the SE process and management within TWRS. Detailed information contained in the TWRS Program SEMP is not repeated in this document. This SEWP and the SE discipline defined within apply to the TWRS Program and new and ongoing TWRS projects or activities, including new facilities and safety. The SE process will

be applied to the existing Tank Farm operations where the Richland TWRS Program Office management determines the process appropriate and where value will be added to existing Tank Farm system and operations.

5462 (WHC-SP–0564-35) **Westinghouse Hanford Company health and safety performance report: Third quarter calendar year 1994.** Lansing, K.A. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 133p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003759. Source: OSTI; NTIS; GPO Dep.

Injury data compiled this quarter shows that Westinghouse Hanford Company (WHC)/Boeing Computer Services, Richland (BCSR) have accomplished a thirty-one percent reduction in lost and/or restricted workday cases from fiscal year 1993 to fiscal year 1994. During the third quarter, WHC/BCSR achieved over one million workhours without a lost workday away injury/illness. This was achieved during the time period from July 16 through August 11, 1994. The contributing experience of each WHC department in attaining this significant improvement is described, along with tables charting specific trends. Starting in fiscal year 1995, the ALARA goal process is undergoing a transition from a calendar year to a fiscal year cycle. Although this appears to run counter to reporting on an annual basis, the purpose of this change is to align the ALARA goal-setting process with the fiscal year budgeting process. It is anticipated that this change will provide facility ALARA Committees another tool for establishing ALARA performance goals that are more meaningful, realistic, and challenging.

5463 (WHC-SP–1094-FY94) **Site Maintenance Plan: Part 2, Site Maintenance Action Plan for FY 1994.** Fisk, E.L. Westinghouse Hanford Co., Richland, WA (United States). Jun 1994. 93p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94018159. Source: OSTI; NTIS; INIS; GPO Dep.

This Fiscal Year (FY) 1994 Site Maintenance Action Plan (SMAP) is Part II of the Site Maintenance Plan, and has been written by Westinghouse Hanford Company (WHC) to outline the requirements stated in DOE Order 4330.4B, Maintenance Management Program, Chapter 1, Paragraph 3.3.1. The SMAP provides an annual status of maintenance initiatives completed and planned, a summary of performance indicators, a summary of maintenance backlog, a listing of real property and capital equipment maintenance cost estimates that were used to create the FY 1996 infrastructure and maintenance budget input, and a listing of proposed line item and general plant projects. Additionally, assumptions for various Site programs are listed to bring the Site Maintenance Plan into focus with overall Site activities. The primary mission at Hanford is to clean up the Site. In this cleanup process WHC will provide scientific and technological expertise to meet global needs, and partnership with stakeholders in the region to develop regional economic diversification. Other missions at the Hanford Site include energy research and development, and waste management and disposal activities. Their primary mission has a 30-year projected life span and will direct the shutting down and cleanup of defense production facilities and the Fast Flux Test Facility. This long-term mission requires continuous maintenance and in many instances, replacement of existing basic infrastructure, support facilities, and utilities. Without adequate maintenance and capital funding these infrastructure, support facilities, and utilities will continue to deteriorate causing an increase in backlogged work.

5464 (WHC-SP–1116) **Overheads, Safety Analysis and Engineering FY 1995 Site Support Program Plan WBS 6.3.5.** DiVincenzo, E.P. Westinghouse Hanford Co., Richland, WA (United States). 27 Sep 1994. 113p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001577. Source: OSTI; NTIS; INIS; GPO Dep.

The Safety Analysis & Engineering (SA&E) department provides core competency for safety analysis and risk documentation that supports achievement of the goals and mission as described in the Hanford Mission Plan, Volume I, Site Guidance (DOE-RL 1993). SA&E operations are integrated into the programs that plan and conduct safe waste management, environmental restoration, and operational activities. SA&E personnel are key members of task teams assigned to eliminate urgent risks and inherent threats that exist at the Hanford Site. Key to ensuring protection of public health and safety, and that of onsite workers, are the products and services provided by the department. SA&E will continue to provide a leadership role throughout the DOE complex with innovative, cost-effective approaches to ensuring safety during environmental cleanup operations. The SA&E mission is to provide support to direct program operations through safety analysis and risk documentation and to maintain an infrastructure responsive to the evolutionary climate at the Hanford Site. SA&E will maintain the appropriate skills mix necessary to fulfill the customers need to conduct all operations in a safe and cost-effective manner while ensuring the safety of the public and the onsite worker.

5465 (WSRC-TR–94-0262) **Sludge source term (PUREX process radionuclide dose impact).** Aponte, C.I. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Jun 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003904. Source: OSTI; NTIS; INIS; GPO Dep.

This report analyzes the radionuclide dose impact of the PUREX process waste stream. The radionuclide ingestion and inhalation pathways are analyzed. Two spent fuel assemblies processed in the Separation facilities are analyzed, the Mark 31A and Mark 31B. The individual radionuclide significance to dose is evaluated in terms of dose percentage. Comparing the radionuclide individual dose value allows the determination of those radionuclides whose dose impact is significant. The results of this analysis demonstrate that a limited number of radionuclides contribute 1% or more to the total dose and that the major contributor to the sludge source dose is strontium. The results obtained permit reducing the list of radionuclides to be considered in the development of source terms to support the High Level Waste Safety Analysis Report.

5466 (WSRC-TR–94-0276-Rev.1) **Supernate source term analysis: Revision 1.** Aponte, C.I. Westinghouse Savannah River Co., Aiken, SC (United States). 13 Oct 1994. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95004347. Source: OSTI; NTIS; INIS; GPO Dep.

The HM Process (modified PUREX) has been used in the H-Canyon since 1959 to recover uranium and byproduct neptunium. The PUREX process has been used in the Separation facilities in F and H-Area. This report analyzes both the inhalation and ingestion radionuclide dose impact of the HM and PUREX process soluble portion of their waste streams. The spent fuel assemblies analyzed are the Mark 16B, Mar 22 for the HM process, and the Mark 31A, Mark 31B for the PUREX process. The results from this analysis are combined with an analysis of the current Safety Analysis Report SAR source term to evaluate source terms for HLW supernate. Analysis of fission yield data and SAR source term values demonstrates that a limited number of radionuclides contribute 1% or more to the total dose and that cesium and plutonium isotopes are the radionuclides with major impact in the supernate source term. This report analyses both volatile and evaporative impact as recommended by DOE guidance. In reality, the only radionuclide volatilized during evaporative conditions is tritium. No evidence of selective volatility occurs during forced evaporation in HLW. The results obtained permit reducing the list of radionuclides to be considered in the development of source terms to support the High Level Waste Safety Analysis Report.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 5248, 5439, 5483, 6171, 7023

5467 (DOE/AN/ACNT–94C, pp. 36-37) **Project Straight-Line: Collection, processing, and dissemination of plutonium storage information.** Mickelsen, B. (Sandia National Labs., Albuquerque, NM (United States)); Cofield, C.; McMichael, J. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

The growing inventory of nuclear materials from the cessation of nuclear weapons production and the accelerated dismantlement activities in the United States and former Soviet Union have led to increased concerns about terrorist activities and the potential for diversion of nuclear materials. These concerns have moved to the United States to offer its excess weapons-grade nuclear materials for international inspections, encouraging reciprocal action by other nations. A unified U.S. plutonium-management system will be needed to handle these increasing needs for storage information; Project Straight-Line at Sandia National Laboratories is developing a pilot system to provide automated remote inventory and monitor the state of health of plutonium in storage.

5468 (EGG–11265-5025) **Integration of video and radiation analysis data.** Menlove, H.O. (Los Alamos National Lab., NM (United States)); Howell, J.A.; Rodriguez, C.A.; Eccleston, G.W.; Beddingfield, D.; Smith, J.E.; Baumgart, C.W. EG and G Energy Measurements, Inc., Los Alamos, NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. Order Number DE95004165. Source: OSTI; NTIS; INIS; GPO Dep.

For the past several years, the integration of containment and surveillance (C/S) with nondestructive assay (NDA) sensors for monitoring the movement of nuclear material has focused on the hardware and communications protocols in the transmission network. Little progress has been made in methods to utilize the combined C/S and NDA data for safeguards and to reduce the inspector time spent in nuclear facilities. One of the fundamental problems in the integration of the combined data is that the two methods operate in different dimensions. The C/S video data is spatial in nature; whereas, the NDA sensors provide radiation levels versus time data. The authors have introduced a new method to integrate spatial (digital video) with time (radiation monitoring) information. This technology is based on pattern recognition by neural networks, provides significant capability to analyze complex data, and has the ability to learn and adapt to changing situations. This technique has the potential of significantly reducing the frequency of inspection visits to key facilities without a loss of safeguards effectiveness.

5469 (LA–12878-MS) **Intrinsic densitometry: In-plant evaluation.** Nishida, K. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)); Kurosawa, A.; Masui, J.; Hsue, S.T. Los Alamos National Lab., NM (United States). Nov 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95004400. Source: OSTI; NTIS; INIS; GPO Dep.

A measurement of the plutonium concentration in a sample is always necessary for nuclear material control and accounting. This report describes the testing of the intrinsic densitometry (ID) technique for implant applications. The authors found that the ID method can determine the plutonium concentrations to between 2 and 3% at concentrations of 100 g/l to 200 g/l with quartz cells and a measurement time of 3600 s. The precision can be improved to 1 to 2% with a higher counting rate. The authors also found that nitric acid concentration and the impurity level of uranium in the product plutonium solution do not affect the concentration measurement. When this technique is applied to plutonium solutions in stainless steel pipes, they found that similar precision in plutonium concentration can be achieved using a high-count-rate detector. The precision, however, is reduced with aged plutonium solutions.

5470 (LA-SUB–94-164) **Setting priorities for action plans at Los Alamos National Laboratory. Final report.** Miller, A.C. Los Alamos National Lab., NM (United States). 30 Sep 1992. 638p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003448. Source: OSTI; NTIS; GPO Dep.

This report summarizes work done by Applied Decision Analysis (ADA) for Los Alamos National Laboratory (LANL) under Subcontract Number 9-XQ2-Y3837-1 with the University of California. The purpose of this work was to develop a method of setting priorities for environmental, safety, and health (ES&H) deficiencies at Los Alamos. The deficiencies were identified by a DOE Tiger Team that visited LANL in the fall of 1991, and by self assessments done by the Laboratory. ADA did the work described here between October 1991 and the end of September 1992. The ADA staff working on this project became part of a Risk Management Team in the Laboratory's Integration and Coordination Office (ICO). During the project, the Risk Management Team produced a variety of documents describing aspects of the action-plan prioritization system. Some of those documents are attached to this report. Rather than attempt to duplicate their contents, this report provides a guide to those documents, and references them whenever appropriate.

5471 (LA-UR–94-3116) **Fuzzy controllers in nuclear material accounting.** Zardecki, A. Los Alamos National Lab., NM (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409112–1: 1. international workshop on fuzzy logic and intelligent technologies in nuclear science (FLINS-1), Mol (Belgium), 14-16 Sep 1994). Order Number DE95000864. Source: OSTI; NTIS; INIS; GPO Dep.

Fuzzy controllers are applied to predicting and modeling a time series, with particular emphasis on anomaly detection in nuclear material inventory differences. As compared to neural networks, the fuzzy controllers can operate in real time; their learning process does not require many iterations to converge. For this reason fuzzy controllers are potentially useful in time series forecasting, where the authors want to detect and identify trends in real time. They describe an object-oriented implementation of the algorithm advanced by Wang and Mendel. Numerical results are presented both for inventory data and time series corresponding to chaotic situations, such as encountered in the context of strange attractors. In the latter case, the effects of noise on the predictive power of the fuzzy controller are explored.

5472 (LA-UR–94-3287) **Potential international safeguards on DOE spent fuel.** Stanbro, W.D. Los Alamos National Lab., NM (United States). [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941207–5: Spent nuclear fuel meeting: challenges and initiatives, Salt Lake City, UT (United States), 14-16 Dec 1994). Order Number DE95000848. Source: OSTI; NTIS; INIS; GPO Dep.

To demonstrate openness to the world community, the US is placing some nuclear material connected with its weapons program under international inspection. Currently this does not include the large amount of spent fuel at Department of Energy (DOE) facilities. This paper presents some possible scenarios that would require international safeguards of spent fuel at DOE facilities. It also describes the likely activities of such an inspection regime.

5473 (LA-UR–94-3691) **Characterization, decontamination and decontrol efforts within the Los Alamos Chemistry Metallurgy Research Facility.** Cucchiara, A.; Olson, K.; Martinez, L.P.R.; Karl, T. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941148–5: ANS meeting on environmental aspects of decommissioning, decontamination, and/or environmental restoration at nuclear and mixed waste facilities, Washington, DC (United States), 13-17 Nov 1994). Order Number DE95003717. Source: OSTI; NTIS; GPO Dep.

The Chemistry Metallurgy Research (CMR) Facility is used to perform analytical chemistry in support of research and development efforts at the Los Alamos TA-55 Plutonium Facility. When DOE Order 5480.11 became effective, more than 50% of this half a million square feet facility was radiologically controlled. In an extraordinary approach to comply with the new order, a concentrated effort was made to systematically characterize, decontaminate and decontrol selected areas within the Facility. A historical record of those areas was obtained by interviewing present and past operating personnel. Whenever possible the Characterization Team and individuals with applicable corporate knowledge conducted tours & inspections. In some cases, precharacterization surveys were conducted to determine the extent of efforts required and the feasibility of decontrolling those areas. The characterization surveys required the generation of thousands of swipes and large area wipes, and the direct survey of all accessible surfaces. As each of the target areas was characterized, it was appropriately posted, in compliance with DOE 5480.1 1, and scheduled for decontamination, as was applicable. Depending on programmatic requirements and

funding, additional portions of the Facility were characterized, decontaminated, resurveyed and decontrolled, as needed, over the last seven years.

5474 (LA-UR–94-3713) **New techniques provide low-cost X-ray inspection of highly attenuating materials.** Stupin, D.M. (Los Alamos National Lab., NM (United States)); Mueller, K.H.; Viskoe, D.A.; Howard, B.; Poland, R.W.; Schneberk, D.; Dolan, K.; Thompson, K.; Stoker, G. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9407123–3: 1994 review of progress in quantitative nondestructive evaluation conference, Snowmass, CO (United States), 31 Jul - 5 aug 1994). Order Number DE95003721. Source: OSTI; NTIS; INIS; GPO Dep.

As a result of an arms reduction treaty between the United States and the Russian Federation, both countries will each be storing over 40,000 containers of plutonium. To help detect any deterioration of the containers and prevent leakage, the authors are designing a digital radiography and computed tomography system capable of handling this volume reliably, efficiently, and at a lower cost. The materials to be stored have very high x-ray attenuations, and, in the past, were inspected using 1- to 24-MV x-ray sources. This inspection system, however, uses a new scintillating (Lockheed) glass and an integrating CCD camera. Preliminary experiments show that this will permit the use of a 450-kV x-ray source. This low-energy system will cost much less than others designed to use a higher-energy x-ray source because it will require a less expensive source, less shielding, and less floor space. Furthermore, they can achieve a tenfold improvement in spatial resolution by using their knowledge of the point-spread function of the x-ray imaging system and a least-squares fitting technique.

5475 (NUREG/CR–0598) **On-site inspection procedures for SNM doorway monitors.** Fehlau, P.E.; Sampson, T.E.; Henry, C.N.; Bieri, J.M.; Chambers, W.H. Nuclear Regulatory Commission, Washington, DC (United States). Office of Inspection and Enforcement; Los Alamos National Lab., NM (United States). Aug 1979. 48p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. (LA–7646). Source: OSTI; NTIS.

This report discusses a program to develop inspection techniques for performance of special nuclear material (SNM) doorway monitors installed at Nuclear Regulatory Commission licensed facilities. The program included a review of performance requirements, a compilation of data on commercially available SNM monitors, the proposal of an inspection scheme, and trial inspections.

5476 (PNL–10062) **Hanford Mission Plan risk-based prioritization methodologies.** Hesser, W.A. (Pacific Northwest Lab., Richland, WA (United States)); Madden, M.S.; Pyron, N.M.; Butcher, J.L. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018618. Source: OSTI; NTIS; INIS; GPO Dep.

Sites across the US Department (DOE) complex recognize the critical need for a systematic method for prioritizing among their work scope activities. Here at the Hanford Site, Pacific Northwest Laboratory and Westinghouse Hanford Company (WHC) conducted preliminary research into techniques to meet this need and assist managers in making financial resource allocation decisions. This research is a subtask of the risk management task of the Hanford Mission Plan as described in the WHC Integrated Planning Work Breakdown Structure 1.8.2 Fiscal Year 1994 Work Plan. The research team investigated prioritization techniques used at other DOE sites and compared them with the Priority Planning Grid (PPG), a tool used at Hanford. The authors concluded that the PPG could be used for prioritization of resource allocation, but it needed to be revised to better reflect the Site's priorities and objectives. The revised PPG was tested with three Hanford programs, the PPG was modified, and updated procedures were prepared.

5477 (UCRL-ID–117455) **Options for the disposition of current inventory of Rocky Flats Plant residues.** Chang, Lychin. Lawrence Livermore National Lab., CA (United States). 16 May 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94017683. Source: OSTI; NTIS; INIS; GPO Dep.

With the end of the Cold War, much concern has been directed towards the accumulation of special nuclear material resulting from the dismantlement of a large number of nuclear weapons. This concern has opened up a debate over the final disposition of the large inventory of weapons-capable plutonium. Technologies for the conversion of plutonium into acceptable forms will need to be assessed and evaluated. Candidate strategies for interim and final disposition include a variety of immobilization techniques (vitrification in glass, ceramic, or metal), conversion to reactor fuel, or direct discard as waste. The selected disposition strategy will be chosen based upon a range of decision metric such as expected conversion costs, equipment requirements, and waste generation. To this end, a systems analysis approach is necessary for the evaluation and comparison of the different disposition strategies. Current data on inventory of plutonium, such as that at the Rocky Flats Plant (RFP), may be useful for the evaluation and selection of candidate disposition technologies. A preliminary analysis of the residues of scrap at Rocky Flats was performed to establish a foundation for comparison of candidate strategies. About 3 metric tons of plutonium and 270 metric tons of other wastes remain in the inventory at Rocky Flats. Estimates on the equipment, facility, manpower, and cost requirements to process this inventory over a proposed 10-year cleanup campaign will provide a benchmark for comparison and assessment of proposed disposition technologies.

5478 (UCRL-JC–117935) **Software evolution in practice for the U.S. Department of Energy.** Wilson, E.F. Lawrence Livermore National Lab., CA (United States). Jul 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9409261–1: ICSM '94: IEEE international conference on software engineering, Victoria (Canada), 21-23 Sep 1994). Order Number DE95004208. Source: OSTI; NTIS; GPO Dep.

The United States Department of Energy (DOE) maintains the nation's supply of special nuclear material. Each year the DOE spends tens of millions of dollars safeguarding this material. As part of this defense program, the DOE has funded Lawrence Livermore National Laboratory (LLNL) to develop and evolve the Argus security system, which provides sophisticated access control and intrusion detection capabilities to some of the Department's facilities. Changes in security and computer technologies impose continuous changes to system requirements. This paper examines the software engineering evolving-changing security system.

5479 (WHC-SD-GN-ES–20012) **Feasibility/alternatives study for the planned replacement of Nuclear Material Safeguards System (NMSS).** McBride, K.C.; Russell, V.K. Westinghouse Hanford Co., Richland, WA (United States). 4 Oct 1994. 102p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004468. Source: OSTI; NTIS; INIS; GPO Dep.

This document is a study which describes the NMSS replacement alternatives and provides recommended solutions. It also describes a NMSS Paradox prototype.

5480 (WHC-SD-SNF-UM–001) **MAC, material accounting database user guide.** Russell, V.K. Westinghouse Hanford Co., Richland, WA (United States). 22 Sep 1994. 98p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004106. Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.

The K Basins Material Accounting (MAC) database system user guide describes the user features and functions, and the document is structured like the database menus. This document presents the MAC database system user instructions which explain how to record the movements and configuration of canisters and materials within the K Basins on the computer, the mechanics of handling encapsulation tracking, and administrative functions associated with the system. This document includes the user instructions, which also serve as the software requirements specification for the system implemented on the microcomputer. This includes suggested user keystrokes, examples of screens displayed by the system, and reports generated by the system. It shows how the

system is organized, via menus and screens. It does not explain system design nor provide programmer instructions.

0560 Legislation and Regulations

Refer also to citation(s) 5275, 5360, 5742, 5743, 5744, 6609, 6610, 6617

5481 (INIS-mf–14428) **Statutory Instrument No. 209 of 1993. European Communities (Radiological emergency warning to public) Regulations, 1993.** Ireland. Jul 1993. 4p. Order Number DE95611310. Source: OSTI; NTIS (US Sales Only); INIS.

These Regulations provide for the implementation of Council Directive 89/618/EURATOM of 27 November 1989, on informing the general public about health protection measures to be applied and steps to be taken in event of a radiological emergency. The Radiological Protection Institute of Ireland is that Competent Authority for the purpose of giving effect to the Regulations.

5482 (INIS-mf–14430) **Statutory Instrument No. 276 of 1994. European Communities (Supervision and control of certain shipments of radioactive waste) Regulations, 1994.** Ireland. Sep 1994. 15p. Order Number DE95611311. Source: OSTI; NTIS (US Sales Only); INIS.

These Regulations provide for the implementation of Council Directive 92/3/EURATOM of 3 February, 1992 laying down conditions for the supervision and control of shipments of radioactive waste between Member States and into and out of the Community, whenever quantities and concentrations of such waste exceed certain levels. These conditions supplement the existing Council Directives on basic safety standards for the health protection of workers and the general public against the dangers of ionising radiation. The Radiological Protection Institute of Ireland has been deemed the Competent Authority for the purpose of implementation of these Regulations in this country and application should be made to that body for all authorisations required under the Regulations.

5483 (INIS-XN–508) **Exchange of Notes constituting an Agreement between the Government of Australia and the Government of the United States of America to bring International Obligation Exchanges under the Coverage of the Agreement concerning Peaceful Uses of Nuclear Energy, and Agreed Minute, of 5 July 1979.** Australia. 16 Dec 1991. 4p. Order Number DE95611318. Source: OSTI; NTIS (US Sales Only); INIS.

This Exchange of Notes, which entered into force on 16 December 1991, refers to the safeguards obligations of both Contracting Parties under their Agreement on the Peaceful Uses of Nuclear Energy and the Exchange of Notes of 2 August 1985 concerning the duration of safeguards. Both Parties agree that the Agreement will apply to the quantity of materials to which either Party, at the request of the other Party, has consented that it should apply as part of the arrangement to exchange safeguards obligations, or that it should no longer apply. (NEA).

5484 (NUREG–0750-Vol.39-Index-1) **Indexes to Nuclear Regulatory Commission issuances, January–March 1994. Volume 39, Index 1.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Jul 1994. 37p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

Digests and indexes for issuances of the Commission, Atomic Safety and Licensing Board Panel, Administrative Law Judges, Directors' Decisions, and Denials of Petitions for Rulemaking are presented in this document. They are intended to serve as a guide to the issuances.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

5485 (INIS-JP–024, pp. B520/1-B520/6) **Production and supply of radioisotopes with reactors in north america and europe current status and future prospects.** Trevena, I. (Nordion International Inc. (Canada)). Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

Reactors have played a key pole in the production of radioactive isotopes for medical applications for the past 50 years. This paper reviews current and future capabilities for the production and supply of radioactive isotopes used in nuclear medicine. It focuses primarily on the supply of fission product molybdenum-99, which is used to produce technetium-99m, the radioisotope most widely employed in nuclear medicine procedures. The significant infrastructure required for the production and supply of molybdenum-99 is detailed, and the capabilities of the major commercial suppliers in North America and Europe are discussed. Plans for increasing production capabilities in the future are also reviewed. (author).

5486 (INIS-JP–024, pp. B530/1-B530/10) **Production and supply of radioisotopes at BATAN.** Hubeis, H. (National Atomic Energy Agency, Jakarta (Indonesia)); Natawiria, W.; Rauf, A.A. Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

BATAN's radioisotope production division has involved in radioisotope production for many years. With two reactors and a cyclotron facility owned by BATAN currently, radioisotopes produced are mainly for use in the field of medical aspects, radiotracers, research purposes, and industrial applications. Production rate has been increased gradually along with the increasing of applicability of radioactive materials for different purposes. The products are intended for supplying both domestic and global demands. (author).

0702 Radiation Sources

Refer also to citation(s) 6253, 6290, 6372, 6373, 6406

5487 (CONF-9405170–3) **A high intensity slow positron facility for the Advanced Neutron Source.** Hulett, L.D. Jr.; Eberle, C.C. Oak Ridge National Lab., TN (United States). [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 10. international conference on positron annihilation; Beijing (China); 23-29 May 1994. Order Number DE94014108. Source: OSTI; NTIS; INIS; GPO Dep.

A slow positron spectroscopy facility, based on ^{64}Cu activation, has been designed for incorporation in the Advanced Neutron Source (ANS). The ANS is a reactor-based research center planned for construction at Oak Ridge, Tennessee, USA. Multiple sources of slow positron beams will be available. One-half mm diameter, copper-coated aluminum microspheres will be activated and transported to a positron spectroscopy building, where they will be dispersed over the surfaces of horizontal pans, 0.1 m^2 in area, located in source chambers. Fast positions from the pans will be intercepted by cylinders coated inside with inert gas moderators. Yields will approach 10^{12} positrons per second before brightness enhancement. Beams will be transported to multiple experiment stations, which will include a 50 meter diameter, 20-detector angular correlation of annihilation radiation (ACAR) spectrometer, and other equipment for materials analysis and fundamental science.

5488 (INIS-JP–024, pp. B110/1-B110/11) **Electron beam coal combustion flue gas treatment developments in Poland.** Chmielewski, A.G. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)). Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

The research on EB(electron beam) flue gas treatment has started in Poland since 1985. It followed early tests performed in Japan, USA and Germany. The first tests using batch method were carried out in Institute of Atomic Energy. The continuous flow laboratory installation (400 Nm^3/h) has been constructed in the Institute of Nuclear Chemistry and Technology (INCT) then. This installation containing ILV-6 electron beam accelerator (power 20 kW, energy of electrons 0-2 MeV) is equipped with additional microwaves generator. The eb or eb/mw energy can be applied to treated flue gas. On the basis of laboratory test an industrial pilot plant has been constructed at EPS Kaweczyn near Warsaw. At this plant being the biggest of this kind (20 000 Nm^3/h) for the first time in industrial conditions multistage irradiation has been applied (two ELW-3 accelerators 50 kW each, energy of electrons 600-800 keV). High efficiency of SO_2 and NO_x simultaneous removal, usable product (fertilizer), lower (in comparison with conventional technologies - FGD/SCR) investment and operational costs are the main advantages which have led to decision about starting demonstration industrial project. Feasibility study has been prepared for EPS Pomorzany, Szczecin, Poland. The plant planned will treat flue gases from power/heat generation block (2 Benson type boilers 56 MW_e plus 40 MW_{th} each). To meet Polish limits of 1997 half of flue gases will be treated with removal efficiency of 90% for SO_2 and 70% for NO_x. Total flow rate will be equal to 270 000 Nm^3/h. (author).

5489 (INIS-JP–024, pp. B120/1-B120/12) **Research and development on municipal Wastewater treatment processes using electron beams.** Kashiwaya, Mamoru (Science Univ. of Tokyo, Noda, Chiba (Japan). Faculty of Science and Technology). Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (In Japanese). (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

This paper was described concerning the experimental results and their engineering evaluations on electron beam irradiation treatment to effluent and sludge produced in existing municipal wastewater treatment plants implemented by the Japan Atomic Energy Research Institute and the study committee for past five years. Laboratory tests using an electron accelerator were carried out for the purposes of disinfection both to effluent and to dewatered sludge. And composting tests by a pilot-plant were also carried out to find the optimal conditions on design and operation, and initial and operational cost estimations for pelletized sludge with/without the irradiation. It was found that these applications to effluent, sludge and supernatant were quite effective. However, several problems awaiting solution were found from the tests and evaluating works on the matters of marketed electron accelerators. As the results of tests and evaluating works, electron beam irradiation treatment process applied to effluent should be carried out at the municipal wastewater treatment plants. Regenerated granular activated carbon treated by electron beam irradiation may also be applicable to remove hazardous organic substances in effluent. However, long-term tests by pilotplants will be necessary to determine the design criteria, operation and maintenance conditions, and so on. For composting of dewatered sludge produced at municipal wastewater treatment plants, several sizes of smaller electron accelerator are required to be on the market. Especially, medium and small sizes municipalities expect to install composting facilities in the plant. (J.P.N.).

5490 (INIS-JP–024, pp. B130/1-B130/11) **Upgrading of oil palm wastes to animal feeds.** Kume, Tamikazu (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment). Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (In Japanese). (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

A huge amount of agricultural wastes are discarded or burned causing the serious environmental pollution problems in the world. Upgrading of these wastes into useful end-products is suggested not only to recycle the agro-resources but also to reduce pollution. Empty fruit bunch (EFB), stalk material after fruit stripping, is a major cellulosic waste of the palm oil industry. The current availability of EFB in Malaysia is estimated to be 3 million tones per year. EFB is normally incinerated to produce bunch ash. Burning and incineration processes emit considerable amount of smokes and pollutants thus affecting surrounding areas. Recently, it has been realized that there is a need to utilize these by-products effectively in order to improve the economic situation of the oil palm industry as well as to reduce pollution problems. EFB is a valuable and useful biomass. This paper describes the production of animal feed and mushroom from oil palm wastes by radiation and fermentation treatment. The process is as follows: decontamination of microorganisms in fermentation media of EFB by irradiation, inoculation of useful fungi, and subsequently production of proteins and edible mushrooms. The dose of 30 kGy was required for the sterilization of contaminating bacteria whereas the dose of 10 kGy was enough to eliminate the fungi. Among many kinds of fungi tested, Coprinus cinereus and Pleurotus sajor-caju were selected as the most suitable microorganism for the fermentation of EFB. The protein content of the product increased and the crude fiber content decreased after solid state fermentation. P.sajor-caju was suitable for the mushroom production on EFB with rich bran and the residue can be used as the ruminant animal feeds. It is expected that the process is applicable to other cellulosic wastes such as sugar cane bagasse, rice straw, etc. produced in other Asian countries, and contribute to reduce the environmental pollution problems. (author).

5491 (INIS-mf–14419, pp. 55-64) **Nuclear track membranes in devices for air cleaning personnel viability support and biotechnological protection.** Vorobiev, E.D. (Joint Inst. for Nuclear Research, Dubna (Russian Federation)); Ovchinnikov, V.V.; Belushkina, I.A. Institute of Nuclear Chemistry and Technology, Warsaw (Poland); Glowny Inst. Gornictwa, Katowice (Poland). 1992. 90p. (CONF-9112186–: 2. meeting on particle track membranes and their applications, Szczyrk (Poland), 2-6 Dec 1991). In *Particle track membranes and their applications. Proceedings of the 2. Meeting 2-6 December 1991, Szczyrk, Poland.* Order Number DE95609886. Source: OSTI; NTIS; INIS.

A brief review of designs development in the field of nuclear track membranes application for air cleaning and keeping clean zones and technological volumes sterile, carried out in Nuclear Reaction Laboratory of JINR, have been presented. Several technical solutions have been shown. That are: find air cleaning filter, local clean work place, gas exchanger, diffusion respirator, bio-technological protection of fermenter and membrane bioreactor. 21 refs, 12 figs.

5492 (INIS-mf–14419, pp. 65-67) **The application of particle track membranes in dactyloscopy.** Bladek, J. (Wojskowa Akademia Techniczna, Warsaw (Poland)). Institute of Nuclear Chemistry and Technology, Warsaw (Poland); Glowny Inst. Gornictwa, Katowice (Poland). 1992. 90p. (CONF-9112186–: 2. meeting on particle track membranes and their applications, Szczyrk (Poland), 2-6 Dec 1991). In *Particle track membranes and their applications. Proceedings of the 2. Meeting 2-6 December 1991, Szczyrk, Poland.* Order Number DE95609886. Source: OSTI; NTIS; INIS.

Short communication. 1 fig. MEMBRANES/particle tracks; ANISOTROPY; CRIME DETECTION; FINGERS; ION BEAMS; LIQUID CRYSTALS; MEETINGS; MEMBRANES; SURFACES

5493 (INIS-mf–14420(Pt.1.2.3)) **IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pts. 1-3.** International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). Order Number DE95610863. Source: OSTI; NTIS; INIS.

The symposium materials contain 19 articles being the actual review on worldwide development in radiation processing of combustion flue gases. The use of electron beams has to be very profitable in SO_2 and NO_x removal. The application of electron accelerators in off-gas systems is very advanced now in Japan, Germany and Poland as well as pilot plants have been constructed there. Their technical details, control equipment, working parameters and obtained results have been presented at the symposium. The list of electron accelerators available on the world market, their beams parameters and new constructions designed for flue gas radiation treatment have been presented, too. Technical possibilities of electric discharges application for flue gas processing has been shown as well. Theoretical models of radiation-chemical reactions initiated by electrons, their mechanism and kinetics (also in heterogenous systems) has been proposed and discussed. 9 refs, 21 figs, 1 tab.

5494 (INIS-mf–14420(Pt.1.2.3), [pp. 31]) **Introduction and historical review of electron beam processing for environmental pollution control.** Frank, N.W. (Ebara Environmental Corp., Greensburg (United States)). International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.1.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The idea of electron beam processing for flue gas cleaning has been shown. The irradiation of the flue gas produces active radicals with react with SO_2 and NO_x to form their respective acids. In the presence of ammonia this acids are converted to ammonium sulfate and ammonium nitrate. Efforts to use radiation to prevent pollution were initiated by Ebara Corporation in Japan in 1970-1971. Very positive results of SO_2 and NO_x removal from the flue gas decided on quick development of that technology not only in Japan. The pilot plants have been built also in Germany (1984 and 1989) and in Poland (1989). The full list of installations in laboratory, pilot and full technical scale working all over the world has been included in the paper. 9 refs, 22 figs, 1 tab.

5495 (INIS-mf–14420(Pt.1.2.3), [pp. 10]) **High power accelerators for flue gas treatment.** Zimek, Z. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)). International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.1.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

A review of electron accelerators manufactured in different counties has been done. Producers and main parameters of low and medium energy transformer accelerators as well as linear induction accelerators available at present time at world market have been specified. 4 tabs.

5496 (INIS-mf–14420(Pt.1.2.3), [pp. 10]) **Chubu pilot plant test.** Aoki, S. (Ebara Corp., Tokyo (Japan)); Doi, Y.; Tokunaga, O.; Namba, H.; Tanaka, T.; Ogura, Y. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.2.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The electron beam plant for the gas purification has been in operation since November 1992. Currently testing on various flue gas conditions are being conducted. The 94% SO_2 and 80% NO_x removal efficiency has already been achieved. The plant is operating smoothly. Optimization of the by-product collector, assuring long life of the electron beam window foil, facility control and various tests for practicability of the plant will be conduced. 5 figs, 2 tabs.

5497 (INIS-mf–14420(Pt.1.2.3), [pp. 8]) **Pilot-scale tests for EB flue gas treatment process in Japan.** Sato, S. (Japan Atomic Energy Research Inst., Takasaki, Gunma (Japan). Takasaki Radiation Chemistry Research Establishment); Tokunaga, O.; Namba, H. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.2.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

A review of electron beam applications for flue gas treatment in Japan has been done. Several pilot plants are being performed for commercial use of electron beams process for cleaning of flue gas from low-sulfur coal burning boiler, a municipal waste incinerator and for removal of NO_x from a ventilation exhaust of a highway tunnel. Outlines of three pilot-scale tests are introduced. 9 refs, 4 figs.

5498 (INIS-mf–14420(Pt.1.2.3), [pp. 29]) **Development of electron beam induced off gas cleaning at the Kernforschungszentrum Karlsruhe.** Paur, H.R. (Kernforschungszentrum Karlsruhe GmbH (Germany). Lab. fuer Aerosolphysik und Filtertechnik 1); Baumann, W.; Lindner, W.; Maetzing, H.; Schikarski, W. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.2.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

A review of Kernforschungszentrum Karlsruhe activities in the field of electron beam use for off gas cleaning has been done. A theoretical as well as application research in the pilot-scale has been conducted. The following main problems have been investigated: improvement of energy efficiency of the electron beam process, optimization of the filter technology, application of the process to other of gas compositions. The results are optimistic. 22 figs, 2 tabs.

5499 (INIS-mf–14420(Pt.1.2.3), [pp. 13]) **Energization of pulse corona induced chemical processes.** Rea, M. (Univ. of Padova, Padova (Italy). Dept. of Electrical Engineering); Yan, K. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

Pilot and laboratory tests have indicated significant technical and economical advantages of air cleaning processes based on pulse corona discharge compared to traditional ones. Experimental results on pulse corona at atmospheric pressure to optimize technical and construction solutions as well as to chose best working parameters to achieve a big number of electrons useful for plasma catalysis have been presented. 16 refs, 8 figs.

5500 (INIS-mf–14420(Pt.1.2.3), [pp. 15]) **Recent results from Polish pilot plant operation.** Chmielewski, A.G. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)). International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on

radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The recent results from Polish Pilot Plant Operation using using electron beam for flue gas cleaning has been presented. The dependence of the removal efficiency of SO_2 and NO_x on dose in single and multistage process has been discussed. The dose distribution has also influenced on the process efficiency. 14 figs.

5501 (INIS-mf–14420(Pt.1.2.3), [pp. 7]) **Nitrogen oxide decomposition by means of electron impact.** Wronski, M. (Politechnika Lubelska, Lublin (Poland)); Pollo, I. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The possibility of application of low energy electrons emitted in electrical discharges for SO_2 and NO_x removal from flue gas has been discussed. Different types of electrical discharges have been taken into account. Experimental results of nitrogen oxide decomposition in high voltage electrical discharges have been shown. 11 refs, 5 figs.

5502 (INIS-mf–14420(Pt.1.2.3), [pp. 6]) **Measurements of nitrous oxide concentration.** Radzio, B. (Institute of Atomic Energy, Otwock-Swierk (Poland)); Licki, J. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The gas chromatography measurement of N_2O content in flue gas has been applied in electron beam pilot plant at Kaweczyn (Poland). The measuring system including the equipment for sample taking and conditioning from off-gas stream has been presented. 4 refs, 4 figs.

5503 (INIS-mf–14420(Pt.1.2.3), [pp. 4]) **Flue gas irradiation effectiveness and dosimetry results of 20,000 Nm^3 pilot plant.** Panta, P.P. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)). International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The flue gas electron beam treatment facilities 5 need a simple, accurate and reproducible dosimetry for gas phase flow systems, especially suitable for electron beam irradiation. The polymer film dosimetry has been used for mapping isodoses inside irradiation vessel and also for electron beam spatial uniformity control. The ozone dosimetric system has been applied for continuous monitoring of averaged dose for flow gas. 1 fig.

5504 (INIS-mf–14420(Pt.1.2.3), [pp. 7]) **Continuous, multichannel monitoring and control system for industrial flue gas treatment by electron beam. Methods and systems of flue gas preparation for further analysis and monitoring.** Sowinski, M. (Soltan Inst. for Nuclear Studies, Otwock-Swierk (Poland)); Plawski, T.; Licki, J. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The continuous, multichannel monitoring and control system for industrial flue gas treatment by electron beam has been designed and tested in the pilot plant in EPS Kaweczyn, Poland. The system consists of the flue gas samples preparation unit and computer flexible distributed I/O system. The last one consists of life data acquisition subsystems: flue gas, water and NH_3 flow control, temperature and pressure measurement. 5 figs.

5505 (INIS-mf–14420(Pt.1.2.3), [pp. 4]) **Project of linear induction accelerator with 500 kW average beam power for flue gas cleanup.** Avramenko, M.I. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (Russian Federation)); Vakhrushin, Yu.P.; Volzbev, A.A.; Demsky, M.I.; Zhestkov, S.N.; Kolesov, N.I.; Kuznetsov, V.S.; Mamykin, V.N. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The authors offer a linear induction accelerator project with 500 kW electron beam power. Accelerator parameters are as follows: accelerated electron energy - 0.7 MeV; electron beam current - 3 kA; pulse duration at half height - 2 ms; pulse repetition rate 120 per sec. The accelerator power is enough for cleaning an electric power station flue gas stream of 100,000 m^3/h. 2 refs, 3 figs.

0703 Isotopic Power Supplies

Refer also to citation(s) 6146

5506 (FNAL/C–94/355-E) **Radioisotope electric propulsion for robotic science missions to near-interstellar space.** Noble, R.J. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9408195–1: Practical robotic interstellar flight conference, New York, NY (United States), 28 Aug - 1 sep 1994). Order Number DE95003502. Source: OSTI; NTIS; INIS; GPO Dep.

The use of radioisotope electric propulsion for sending small robotic probes on fast science missions several hundred astronomical units (AU) from the Sun is investigated. Such missions would address a large variety of solar, interstellar, galactic and cosmological science themes from unique vantage points at 100 to 600 AU, including parallax distance measurements for the entire Milky Way Galaxy, sampling of the interstellar medium and imaging of cosmological objects at the gravitational lens foci of the Sun ($\geq$ 550 AU). Radioisotope electric propulsion (REP) systems are low-thrust, ion propulsion units based on multi-hundred watt, radioisotope electric generators and ion thrusters. In a previous work, the flight times for rendezvous missions to the outer planets ($<$ 30 AU) using REP were found to be less than fifteen years. However fast prestellar missions to several hundred AU are not possible unless the probe's energy can be substantially increased in the inner Solar System so as to boost the final hyperbolic excess velocity. In this paper an economical hybrid propulsion scheme combining chemical propulsion and gravity assist in the inner Solar System and radioisotope electric propulsion in the outer Solar System is studied which enables fast prestellar missions. Total hyperbolic excess velocities of 15 AU/year and flight times to 550 AU of about 40 years are possible using REP technology that may be available in the next decade.

5507 (WHC-SD-RTG-WP–001) **Work plan for the fabrication of the radioisotope thermoelectric generator transportation system package mounting.** Satoh, J.A. Westinghouse Hanford Co., Richland, WA (United States). 9 Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004152. Source: OSTI; NTIS; INIS; GPO Dep.

The Radioisotope Thermoelectric Generator (RTG) has available a dedicated system for the transportation of RTG payloads. The RTG Transportation System (System 100) is comprised of four systems; the Package (System 120), the Semi-trailer (System 140), the Gas Management (System 160), and the Facility Transport (System 180). This document provides guidelines on the fabrication, technical requirements, and quality assurance of the Package Mounting (Subsystem 145), part of System 140. The description follows the Development Control Requirements of WHC-CM-6-1, EP 2.4, Rev. 3.

0704 Economic, Industrial, and Business Aspects

5508 (INIS-mf–14420(Pt.1.2.3), [pp. 12]) **Economics of the electron beam process.** Frank, N.W. (Ebara Environmental Corp., Greensburg (United States)). International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.1.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The economical analysis of the costs for electron beam process of flue gas treatment has been done in Ebara Corp. storing since 1988. Now, with current improvements in the process and with the advent of modular lower cost accelerators, it is believed that the electron beam process rated equivalent or preferable to classic technologies of SO_2 and NO_x removal from flue gas. 3 refs, 6 figs.

08 HYDROGEN

0801 Production

Refer also to citation(s) 5518, 5520, 5565, 5566, 6078

5509 (DOE/METC–94/1008-Vol.2, pp. 703-708) **High temperature size selective membranes.** Zhou, S.J. (AlliedSignal, Inc., Des Plaines, IL (United States)); Anderson, D.J.; Til, A.E. van. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-92MC29245. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objective of this research is to develop a high temperature size selective membrane capable of separating gas mixture components from each other based on molecular size, using a molecular sieving mechanism. We are evaluating two concepts: A composite of a carbon molecular sieve (CMS) with a tightly defined pore size distribution between 3 and 4 Å, and a microporous supporting matrix which provides mechanical strength and resistance to thermal degradation, and a sandwich of a CMS film between the porous supports. Such a membrane would enable the separation of hydrogen from other gases.

5510 (DOE/METC–94/1008-Vol.2, pp. 709-713) **A catalytic membrane reactor for facilitating the water-gas shift reaction at high temperature.** Edlund, D.J. (Bend Research, Inc., OR (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FG03-91ER81229. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

This program is directed toward the development of a metal-membrane-based process for the economical production of hydrogen at elevated temperature by the reaction of carbon monoxide with steam - i.e., the water-gas shift (WGS) reaction. Key to achieving this objective is the development of an inexpensive and durable metal-membrane module. The specific program objectives include the following: design, fabrication, and demonstration of prototype membrane modules; improving the membrane composition to increase the hydrogen flux; demonstrating that membrane lifetime $\geq$ 2 years is likely to be achieved; and conducting engineering and economic analyses of the process.

5511 (DOE/METC–94/1008-Vol.2, pp. 714-720) **New developments in hydrogen permselective membranes.** Gavalas, G.R. (California Institute of Technology, Pasadena, CA (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-90MC26365. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of the original project was to develop silica hydrogen permselective membranes and evaluate the economic feasibility of these membranes in hydrogen production from coal gas. The objectives of the work reported here were to increase the membrane permeance by developing new precursors or deposition conditions, and to carry out fundamental permeability measurements of the membrane at different stages of pore narrowing.

5512 (DOE/METC–94/1008-Vol.2, pp. 721-726) **Preparation and characterization of composite membrane for high temperature gas separation.** Ilias, S. (North Carolina A&T State Univ., Greensboro, NC (United States)); King, F.G.; Su, N. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FG22-93MT93008. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

To develop a new class of permselective inorganic membranes, we have identified electroless plating as a potential route to deposit a thin metal film on porous substrate. Electroless plating is a controlled autocatalytic deposition of a continuous film on the surface of a substrate by the interaction of a metal salt and a chemical reducing agent. This method can give thin films of metals, alloys and composites on both conducting and nonconducting surfaces. The objective of this project is to develop thin film palladium membranes for separation of hydrogen in high temperature applications. We plan to use electroless plating to deposit thin palladium films on microporous ceramic and silver substrates and then characterize the membrane in terms of permeability and selectivity for gas separation. To accomplish the research objective, the project requires three tasks: (i) Development of a process for composite membrane fabrication; (ii) Characterization of composite membrane; (iii) Development of theoretical model for hydrogen gas separation.

5513 (NEI-FI–248, pp. 33-41) **A photovoltaic-zero-gap alkaline experiment.** Bjerke, B. (Oslo Univ. of Technology (Norway). Dept. of Technical Physics). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

The performance of a hydrogen production system by means of photovoltaic solar energy conversion and water electrolysis are studied. The system consists of a 60W semicrystalline photovoltaic array and a zero-gap alkaline electrolyzer of own construction. The different parts of the system have been tested under static and dynamic operation conditions. Different power conditioning methods are discussed and results from direct coupling are presented. A method for optimal power transfer by means of thermal optimization is proposed.

5514 (NEI-FI–248, pp. 71-79) **Iceland: - A forum for gradual introduction of hydrogen as marine fuel.** Arnason, B. (Univ. of Iceland (Iceland)); Jonsson, V.K. Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium

on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

The paper presents the estimated production cost of hydrogen if produced in Iceland from domestic hydro energy and possibly also geothermal energy. The cost of producing gaseous hydrogen by electrolysis is calculated for various alternatives such as plant size, load factors, energy cost and different electrolysis technologies. Furthermore preliminary calculations of the liquefaction cost of hydrogen, based on the Linde technology, have been made for one plant size. Assuming 100 MW plant size, Norsk Hydro technology and electricity price 0.0185 US dollar/kWh gaseous hydrogen production cost would be 0.172 US dollar/Nm^3H_2. Liquid hydrogen would cost approximately twice as much as hydrogen gas. The paper also discusses the idea of powering the Icelandic fishing fleet by hydrogen. The Icelandic fishing fleet, a very large consumer of imported fuel, needs a relatively simple infrastructure. This makes it attractive to start the transition from oil to hydrogen gradually by building up relatively small hydrogen plants located in several strategic fishing villages around the country and simultaneously modifying the fishing vessels for hydrogen gradually. Since liquid hydrogen is two times as expensive as hydrogen gas it is assumed that the hydrogen can be stored on board vessel as gas bound in magnesium hydride . When the gas has to be used it can be released from the hydride using the exhaust heat from the engine. An advantage of this storage method is the possibility of using the heat released, when the vessels are refuelled, on land for space heating within the villages located near to the fuelling harbors. It is argued that a transition from imported oil to hydrogen produced from domestic energy sources may be a feasible future option for Iceland.

5515 (ORNL/FMP–94/1, pp. 51-61) **Hydrogen production using inorganic membranes.** Fain, D.E. (Oak Ridge K-25 Site, TN (United States)); Roettger, G.E. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The plan for developing ceramic membranes to separate hydrogen from gasified coal has been to fabricate membranes with gradually decreasing pore size, to study the transport mechanisms, and to determine the pore size needed to achieve large separation factors at high permeance. The transport properties and separation factors of the membranes are being measured with various gases at increasing temperatures. A mathematical model was developed using known transport mechanisms. The transport data is being used to continually evaluate and improve the model. Experimentally, it has been observed that the separation factor, measured at room temperature, decreases as the pore radius decreases from about 30 to 5 angstroms. Without the guidance of the mathematical model, we would have concluded long ago that the probability of fabricating a ceramic membrane with a high separation factor was extremely low and terminated the project. However, the model indicated that at sufficiently low pore size, the separation factor would reach a minimum and start increasing rapidly toward an infinite separation factor. The progress has been slower than was expected because of difficulties in accurately characterizing the membrane pore size. A new method using the mathematical model to interpret data from a high temperature flow test system has been developed to estimate the pore size. Progress is now continuing toward decreasing the pore size. A large number of membranes have been evaluated over the range of pore radii from 30 Å to about 2.5 Å. Transport measurements have been made and separation factors evaluated for 15 of those membranes over a temperature range of 22 to 275°C and a pressure range of 85 to 185 cm hg. The smallest pore size membrane appears to have a mean pore radius of about 2.5 Å and a high temperature extrapolated separation factor for helium and carbon tetrafluoride of 330.

0802 Storage, Transport, and Handling

Refer also to citation(s) 5558, 5559, 5565, 5566, 5587

5516 (NEI-FI–248) **Hydrogen and fuel cells for energy storage.** Lund, P. (ed.). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. 166p. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). Order Number DE95723907. Source: OSTI; NTIS.

The first Nordic Symposium on Hydrogen and Fuel Cells for Energy Storage was held on March 11-12, 1993 at the premises of the Helsinki University of Technology in Espoo-Otaniemi. The initiator and main sponsor of this Symposium was the Nordic Energy Research Programme and its Committee for Fuel Cells. The major objective of the seminar was to present recent developments and research activities on the use of hydrogen and fuel cells for energy storage purposes. Emphasis was laid on smaller systems applicable e.g. for autonomous energy production. Hydrogen storage, conversion of hydrogen into final energy, and on-site production of hydrogen e.g. by renewable energy sources were considered. Besides basic scientific issues and components, system technology aspects were also discussed. New areas for further Nordic cooperation were identified during the symposium. The seminar was attended by almost 60 persons from all Nordic countries. Furthermore, three world-known scientists gave their overview on the status and trends of the hydrogen technology. This proceeding comprises the papers presented at the symposium.

5517 (NEI-FI–248, pp. 43-50) **H_2 production through wind energy.** Yde, L. (Folkecenter for Renewable Energy, Hurup Thy (Denmark)). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

The hydrogen plant at Folkecenter for Renewable Energy is to form a component of the energy system of the 'Village for Green Research' When the Village for Green Research has been fully built out it will consists of: Training centre, Center for Green Technology, Aqua-farmning and An energy system based 100 % on solar and wind. At the Village for Green Research techniques will be researched which can be used in the villages of the future, including renewable energy techniques. The energy system of the Village for Green Research will consist of the following plants: 110 kW windpower plant, Plus Energy House, Consumer management system and 20 kW hydrogen plant. The windpower Plant supplies electricity and electric heating to the Village. The surplus production is lead to the public grid. The Plus Energy House produces heat which via the district heating grid is used for heating of rooms and heating domestic water in the Village. The consumer management system is used for minimizing the prices of electricity. The hydrogen plant consists of an electrolysis plant of 20 kW, a hydrogen storage of 600 NM^3 in a 10 bars pressure vessel and district heating grid of the Village. The electrolysis plant is designed for production of hydrogen and oxygen by water electrolysis. The ion discharge on electrodes and chemical reactions occur at current flow through the electrolytic solution. Next equation shows water electrolysis with hydrogen and oxygen production: $H_2O = H_2 + 1/2\ O_2$.

5518 (NEI-FI–248, pp. 81-84) **Review of hydrogen technology in Denmark.** Schleisner, L. (Risoe National Lab., Roskilde (Denmark)). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

In Denmark there exists some experience and know-how in handling hydrogen especially concerning metal hydride systems. During the 1980s research was carried out at Risoe National Laboratory concerning the reaction between hydrogen and different metals. The work has been carried out as well as own separate projects as in collaboration especially with Norsk Hydro and the Institute of Energy Technology in Kjeller, Norway. The experimental work stopped in 1988, as no further financial support was possible. The metal hydride work in Denmark was mainly concentrated on pure magnesium (Mg) and the alloy FeTi, making the stochiometric connection $FeTiH_2$. Most of the work was concentrated on Mg, as the material is light and cheap. The experiments made at Risoe

showed that magnesium is a material qualified for storage of hydrogen, because the necessary reactions pass off sufficiently fast. Some cycle experiments were made repeating the storage process on the same amount of metal, but with a new amount of hydrogen in each cycle. This was done to see, if the process could be repeated without changing characteristics. Experiments of about thousand cycles showed that the storage capacity decreased a little, but the velocity for filling and emptying the system was unaffected. In Denmark hydrogen is used in many different industrial processes with a consumption of about 4,5 millions Nm^3 per year. The different processes using hydrogen are: hardening of sebacic acids, heat treatment, chemical process technology, optical fibre production, burning for heating purposes, cooling gas, pharmaceutical industry, catalysts and weather balloons.

5519 (NEI-FI–248, pp. 85-91) **Hydrogen and fuel cells Finnish activities.** Nieminen, J.P. (Neste Oy, Porvoo (Finland)). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

Finnish activities on fuel cells were quite modest for long time, but interest in hydrogen as a storage media has been higher during last few years. Today there is research activities both on fuel cell development and on whole hydrogen based storage systems. Activities are mainly at research laboratories, but also industrial activities exists.

5520 (NEI-FI–248, pp. 93-102) **Review of activities in Norway.** Andreassen, K. (Norsk Hydro, Oslo (Norway). Research Centre Porsgrunn). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

This article is an overview of Norwegian activities of using hydrogen and fuel cells for energy storage. The projects concerning hydrogen energy systems are named: Hydro energy in Germany, Hydrogen as a fuel in the Norwegian transportation sector and Photovoltaic based hydrogen energy systems. The other part of the projects is concerning system elements based on water electrolysis, electrode activation and metal hydrides, which are: 1. Hydrogen energy systems consisted of Norwegian Hydro energy in Germany, Hydrogen as a fuel in the Norwegian transportation sector and Photo voltaic based hydrogen energy systems and 2. System elements consisted of water electrolysis, electrode activation and metal hydrides.

5521 (NEI-FI–248, pp. 137-158) **Hydrogen storage alloy and metal hydride battery.** Tetsuo, Sakai (Government Industrial Research Inst., Osaka (Japan)); Noreus, D. Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

More than 20 years have passed since the discovery of hydrogen storage alloys. Various applications such as hydrogen storage tank, chemical heat pump, hydrogen purification system, compressor, actuator, hydrogen battery etc., have been proposed and many alloys have been developed, accumulating huge experimental data. Basic understanding of the alloys and hydrides have made great progress concerning metallurgy, crystallographic structure, surface structure, hydrogen diffusivity, thermodynamic properties, electrochemical properties etc. In Japan, since 1974 very extensive R and D works on hydrogen energy have been conducted under national projects called 'Sunshine' sponsored by Ministry of International Trade and Industry (MITI). The accumulated data have led to the first industrial success of the metal hydride battery in 1990. The increasing global environmental problems are looking for solution in hydrogen energy system, further increasing the position of metal hydrides as a key material. In this report, we would like to introduce several energy- related applications of the hydrides that have occurred in last 3 years.

0830 Combustion

Refer also to citation(s) 6143

09 BIOMASS FUELS

Refer also to citation(s) 6071, 6170

0907 Resources

5522 (DOE/CH/10093–245, pp. 215-222) **Biomass feedstocks in the midwest.** Denzler, E.W. (Union of Concerned Scientists, Cambridge, MA (United States)); Brower, M.C.; Tennis, M.W. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

In early March, 1993, the Union of Concerned Scientists released a report on a two-year study assessing the economic benefits and technical potential of renewable electricity in the Midwest. As part of that study, we evaluated potential biomass feedstocks which might come from existing sources, such as agricultural residues, logging and mill residues, and municipal solid wastes. We estimate the potential biomass resource from these sources to be over 100 million dry tons annually. Future biomass feedstocks could come from energy crops grown on idle agricultural land, which we estimate could produce in excess of 200 million dry tons annually, under certain scenarios. The economic attractiveness of many of these feedstocks will depend on the conversion technology considered. This paper describes our assessment of biomass resources and summarizes some of our results.

0908 Production

Refer also to citation(s) 4948, 6162

5523 (CONF-940780–Vol.2, pp. 557-561) **Photosynthetic conversion of CO_2 to biomass.** Brown, L.M. (National Renewable Energy Lab., Golden, CO (United States)); Zeiler, K.G.; Talbot, S.G.; Heacox, D.A. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

There is an increasing amount of work being done on the issue of the growth of microalgae in flue gas. Several studies have addressed the growth of microalgae at high levels of CO_2. An early set of chemostat experiments with the prasinophycean alga Tetraselmis suecica employed flue gas collected from a oil-fired generating station collected in large teflon sampling bags then brought to the laboratory for injection into chemostats. The algae grew, but the authors suspected that the method of collection of the flue gas resulted in the inclusion of large amounts of air in the flue gas sample.

5524 (DOE/CH/10093–245, pp. 77-87) **Bacteria for power alcohol yeast for bread and beer.** Doelle, M.B. (Microbiotech Pty Ltd., Maroochydore South (Australia)); Wilkinson, R.R. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Zymonomas offers the following advantages over yeast, using starch - or sucrose-based renewable resources: (1) Shorter fermentation time. (2) Reduced contamination risk because of its fast growth and ethanol production. (3) Higher ethanol tolerance. (4) No fusel oils, glycerol or lactic acid formation. Ethanol is almost parmaceutical grade, reducing the BOD in the effluent markedly. (5)

Cascading inoculum technique eliminates regular cleaning and sterilization of fermenters, allowing a faster turn around time. (6) Significant reduction of foaming and less cooling because of less heat produced from the lower required cell population, and a higher temperature tolerance. (7) Centriguation and biomass recycle can be eliminated and replaced by the cascading technique. (8) Distiller's dried grain (DDG) contains higher protein, 34% against 30%, and is FDA approved. (9) Sterilization of raw material an obsolete requirement. (10) Liquid effluent recycle of 50% possible. These advantages that bacteria, Zymomonas mobilis, holds over yeast allow for a more economical and environmentally friendlier way of producing power alcohol. This paper provides the detail and background which support these claims.

5525 (DOE/CH/10093–245, pp. 88-102) **Alcohol production by continuous cofermentation of whey and corn.** Zhou, K.P. (Univ. of Nebraska, Lincoln (United States)); Yang, H.H.; Shahani, K.M. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Whey, a waste product of the cheese industry, was utilized as the liquid portion of corn starch mash and to supply about 28% of the fermentable carbohydrates as lactose for alcohol fermentation. Initially, in a continuous cofermentation of whey-corn mixture, using free cells of Kluyveromyces marxianus and Saccharomyces cerevisiae, Kluyveromyces marxianus from the first fermentor would take over the Saccharomyces cerevisiae in the second fermentor, resulting in longer fermentation by whey-corn cofermentation, using immobilized yeast, has been developed - involving a separate fermentation of the lactose from the whey using immobilized Kluyveromyces marxianus in the first fermentor, followed by the fermentation of the corn sugar using immobilized Saccharomyces cerevisiae in the second fermentor. The total fermentation time for the complete utilization of sugar was reduced to only 28 hrs (compared to 114 hrs by the conventional single culture batch process), and a final ethanol concentration of 10.9% v/v (95% of theoretical value) was obtained from whey-corn mixture. This continuous cofermentation process appears to possess a potential of significant savings in raw material an labor costs in the alcohol manufacture.

5526 (DOE/CH/10093–245, pp. 199-206) **The influence of pressure and some gas additivies on the high pressure oxidation of methane to methanol.** Arutyunov, V.S. (Institute of Chemical Physics, Moscow (Russian Federation)); Vedeneev, V.I.; Leonov, V.E.; Krymov, N.Yu.; Sedykh, A.D. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The practical realization of a process that permits direct natural gas to methanol requires investigation of optimal operating conditions. The primary operating conditions of concern are pressure and permissible nitrogen content if air is used instead of oxygen. Low conversion of natural gas to methanol with high pressure oxidation makes it advantageous to recycle the reacting gases. The presence of carbon monoxide and hydrogen in recycling gases can cause some problems due to their high reactivity. The influence of these gases as well as that of operating pressure changes in the range of 20-230 atm and dilution with nitrogen (up to 70%) on the process, was investigated experimentally.

5527 (ETDE/DE-mf–95726395) **Energy crops and crops for industrial use.** Veitshoechheimer Berichte aus der Landespflege, v. 15. Bayerische Landesanstalt fuer Weinbau und Gartenbau, Veitshoechheim (Germany). Abt. Landespflege. 1993. 62p. (In German). Order Number DE95726395. Source: OSTI; NTIS (US Sales Only).

With a view to the cultivation of high yield plant species as possible alternative crops in agricultural overproduction areas and their use as renewable energy sources or industrial feedstocks, a test series establishing cultivation properties, yield, nutrient demands and suitable reproduction methods was carried through with different undemanding grass species. The report presents first results of this work. The established yields permit the conclusion that Miscanthus and comparable grasses may hold the possibility for economic use, granted that energy generation techniques and raw material processing techniques are developed further. (EF)

5528 (ETDE/DE-mf–95733292) **Guide to efficient and environmentally benign production of winter rapeseed.** Graf, T.; Degner, J. Landwirtschaftliche Untersuchungs- und Forschungsanstalt (LUFA) Thueringen, Jena (Germany). 1993. 23p. (In German). Order Number DE95733292. Source: OSTI; NTIS (US Sales Only).

The rearing, cultivation, and marketing of rapeseed are described from the agricultural viewpoint. Further, the market prospects and uses of rapeseed oil are discussed. Besides serving as a raw material for the food and chemical industries, rape oil can also be exploited as a fuel. (EF)

5529 (ETDE/DE-mf–95733405) **Cultivation techniques for short rotation plantations.** Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Institut fuer Oekonomie. Arbeitsbericht, v. 90/2. Diederichs, W. Bundesforschungsanstalt fuer Forst- und Holzwirtschaft, Hamburg (Germany). Inst. fuer Oekonomie. Aug 1990. 27p. (In German). Order Number DE95733405. Source: OSTI; NTIS (US Sales Only).

This work deals with cultivation techniques at short-rotation plantations. A relevant literature research was carried through. The following individual results regarding the different stages of work are to be summed up: Tree species: poplar including aspen, alder, and willow, of which poplar species are most commonly used. Soil preparation: Thorough digging in autumn before planting small plants. Some larger plants may be planted without prior digging or with reduced soil preparation effort. Planting: Dependent on spacing respectively the number of plants, plant material, and soil condition. Small plants planted closely to each other and with intensive soil working are planted mechanically. In other cases planting is done by hand. Protective measures: Especially chemical and manual weed control as well as fencing. Frequently, advance treatment with chemicals in the autumn before planting is recommended. Touching up/care: German authors recommend touching up from a 20% rate of failure. Fertilization: Regular fertilization is required because of the frequent and intensive landuse. - As the description of these partial tasks is mainly without consideration of the objective pursued, economy, and site conditions, it is not possible to establish process chains for the different forms of short rotation plantations. (orig./UWA)

5530 (VF-UB–93-28) **Amount of tree residues following harvesting of wood fuel.** Eriksson, L.G. Vattenfall Utveckling AB, Vaellingby (Sweden). Aug 1994. 46p. (In Swedish). Project Bioenergy-38190-49. Order Number DE95723965. Source: OSTI; NTIS.

Project Skogskraft, report nr 20.

In order to establish methods for and extent of determinations of the amount of remaining tree residues, a pilot study was made of a specific area. Here we laid out 1 m^2 plots and found that in 65 of 70 test plots the divergence from the mean value was 16% at 67% probability, corresponding to 31% at 91% probability, which was acceptable to our principal. The main study, on three areas, was conducted as fresh brush removal where no 'needles' had fallen off. The removal varied between 30-40 tonnes of dry matter per hectare. On the area with the most favourable logging conditions and the largest share of spruce, 24% of the total amount of tree residues were left. With a reduced share of spruce and more difficult logging conditions, the share of remaining tree residues increased to 31 and 34% on the two other areas. In the main study, the same statistical significance was obtained as the pilot study. In one area, the theoretical amount of remaining tree residues was calculated under the assumption that the needles had been allowed to fall off before forwarding. The result showed that the remaining share increased from 32% to 52%. Here, thus, the needles were theoretically 18% of the total amount of tree residues. The tree residues left were unevenly spread over the felling areas, which resulted in a large divergence from the mean value of the

test areas. Tree residues that were between 2 and 5 cm thick occurred with between 12 and 17%, and those larger than 5 cm between 6 and 8% of the total amount of remaining tree residues. 3 refs, 10 figs, 5 tabs

0909 Processing

Refer also to citation(s) 6166

5531 (CIEMAT–754) **Lignocellulosic biomass. Constitutive polymers. Biotechnological processes of lignin biodegradation.** Martin, C.; Manzanares, P. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 32p. (In Spanish). Order Number DE95730395. Source: OSTI; NTIS.

The structure of the Lignocellulosic materials and the chemical composition of their main constitutive polymers, cellulose, hemicelluloses and lignin are described. The most promising transformation processes according to the type of biomass considered: hardwood, softwood and herbaceous materials as well as the mechanisms for lignin biodegradation and the perspectives of biotechnological processes for biopulping, biobleaching and effluents decolorization in the paper pulp industry are also discussed. (Author)

5532 (CONF-940601–1) **Current status of the IGT RENUGAS® process.** Lau, F.S.; Carty, R.H. Institute of Gas Technology, Chicago, IL (United States). [1994]. 5p. Sponsored by Institute of Gas Technology, Chicago, IL (United States). From 19. world gas congress; Milan (Italy); 6-9 Jun 1994. Source: OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616.

The RENUGAS process was specifically developed for pressurized fluidized bed gasification of biomass to produce either an industrial fuel gas or a chemical synthesis gas depending on air- or oxygen-blown operation. The RENUGAS gasifier is a single state fluidized bed reactor with a deep bed of inert solids that provide stable fluidization behavior and needed heat capacity for efficient transfer of energy released by the combustion to the endothermic devolatilization and gasification reactions. The use of a deep single-stage bed of inert solids yields high carbon conversion and low production of oils and tars. The 11 metric tons per day RENUGAS process development unit built at IGT under a USDOE program, has been tested under various operating conditions with a variety of feedstocks from RdF to woody and herbaceous biomass. Currently, the PDU is being used to test hot gas cleanup for power turbines in support of the Hawaii demonstration gasifier. Biomass conversions of over 95% were achieved for most biomass tested. The successful demonstration of the PDU tests resulted in RENUGAS being selected for further scaleup a 91 metric ton per day demonstration gasifier being constructed in Hawaii by the Pacific International Center for High Technology Research (PICHTR); a research program being conducted by Westinghouse Electric to validate a hot gas cleanup system for operation of the RENUGAS gasifier with a gas turbine; and the feasibility study of a 70-80 Megawatt combined cycle power plant using an air blown RENUGAS gasifier with alfalfa stems as the feedstock. In this paper, the development of the IGT RENUGAS process from a concept in 1977 to its status in three current programs is discussed.

5533 (CONF-940812–19) **Development of the IGT RENUGAS® process.** Lau, F.S.; Carty, R.H. Institute of Gas Technology, Chicago, IL (United States). [1994]. 6p. Sponsored by Institute of Gas Technology, Chicago, IL (United States). From 29. intersociety energy conversion engineering conference; Monterey, CA (United States); 7-12 Aug 1994. Source: OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616.

The RENUGAS process was specifically developed for pressurized fluidized bed gasification of biomass to produce either an industrial fuel gas or a chemical synthesis gas depending on air- or oxygen-blown operation. The RENUGAS gasifier is a single stage fluidized bed reactor with a deep bed of inert solids that provide stable fluidization behavior and needed heat capacity for efficient transfer of energy released by the combustion to the endothermic devolatilization and gasification reactions. The use of a deep single-stage bed of inert solids yields high carbon conversion and low oils and tars production. The 11 metric tonne per day RENUGAS process development unit (PDU) built at IGT under a US DOE program, has been tested under various operating conditions with a variety of feedstocks from RdF to woody and herbaceous biomass. Currently, the PDU is being used to test hot gas cleanup for power turbines in support of the Hawaii demonstration gasifier. Biomass conversions of over 95% were achieved for most biomass tested. The successful demonstration of the PDU tests resulted in RENUGAS being selected for further scaleup to a 91 metric ton per day demonstration gasifier being constructed in Hawaii by the Pacific International Center for High Technology Research (PICHTR); a research program being conducted by Westinghouse Electric to validate a hot gas cleanup system for operation of the RENUGAS gasifier with a gas turbine; and the feasibility study of a 70-80 Megawatt combined cycle power plant using an air blown RENUGAS gasifier with alfalfa stems as the feedstock. In this paper, the IGT RENUGAS process is described and its status in three current programs is discussed.

5534 (DOE/CH/10093–245, pp. 207-212) **Demonstration of methanol production using the hydrocarb process with biomass feedstock.** Unnasch, S. (Acurex Environmental Corp., Mountain View, CA (United States)). National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

A bench scale methanol production plant, using biomass and natural gas as feedstocks, is being built in Southern California with the goal of verifying the feasibility of the Hydrocarb process. The Hydrocarb process, developed by Brookhaven National Laboratory, involves three steps: the hydrogasification of biomass; the pyrolysis of methane into hydrogen and solid carbon; and the catalytic reaction of hydrogen and carbon monoxide into methanol. Excess hydrogen from the methanol production step is recirculated and provides the reducing environment in the hydrogasification process. A preliminary design has been completed, engineering activities are underway, and the project is ready to move to the construction phase.

5535 (ETDE/DE-mf–95726982) **Development of an expert system for process control of bioreactors in a sewage system. Final report.** Bieker, B.; Rueckert, H. Bayer AG, Leverkusen (Germany). Aug 1989. 44p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT ITW8503C. Order Number DE95726982. Source: OSTI; NTIS (US Sales Only).

This is a concise and informative report by Bayer AG in the main results of R + D note on an on-line expert system for the Leverkusen sewage treatment plant. (orig.)

5536 (NEI-DK–1748) **Inhibition of hydrogen sulfide formation in a biogas reactor by means of iron compounds addition.** Lund, B. Dansk Teknologisk Inst., Taastrup (Denmark). Nov 1993. 56p. (In Danish). Contract ENS-1383/92-0001. Order Number DE95723848. Source: OSTI; NTIS.

EFP-92.

Addition of iron salts to a laboratory biogas reactor in order to educe hydrogen sulfide concentration in the gas phase has been tested. The effect of molar concentrations of iron (different counterions), of the hydraulic load and process temperature has been examined. Influence of iron compounds addition upon the bacterial flora composition (methane producing and sulfate reducing) as well the rate of sulfate reduction have been tested. Results were compared with data from the operating full-scale biogas plants in Denmark. Laboratory experiments proved the addition of iron sulfate to have no effect on the hydrogen sulfide level in gaseous phase, quite as expected. Addition of iron chlorides so, as to achieve a molar ratio iron/sulfide in the bioreactor to be 1:1, or surplus iron/sulfide, resulted generally in a reduction of H_2S concentration in the gas by 60-80 % compared to untreated controls. However further increasing concentrations of iron chloride did not further reduce the H_2S concentration in the produced biogas beyond 80 %. No measurable difference was observed while using

Fe^{2+} instead of Fe^{3+} salts. The effect was independent on the reactor temperature as well, and followed similar patterns in the mesophilic and thermophilic bioreactors. Iron salts have different effect depending on the start concentration and hydraulic load. At high initial concentration > 2500 ppm H_2S and short retention time (15 days), higher concentrations of iron ions (molar Fe/S ratio 4:1 is more effective than 2:1) were found necessary in order to achieve less than 700 ppm H_2S in the gaseous phase. (EG)

5537 (VTT-TIED–1573) **Assessment of liquefaction and pyrolysis systems.** Solantausta, Y. (VTT Energy, Espoo (Finland)); Diebold, J.; Douglas, C.E.; Bridgwater, T.; Beckman, D. Technical Research Centre of Finland, Espoo (Finland). 1994. 204p. Order Number DE95723879. Source: OSTI; NTIS.

This report summarizes the results of the IEA Biomass Agreement Pyrolysis/Liquefaction activity from 1989 to 1991. A summary of the developments of state of the art of direct biomass pyrolysis and liquefaction technology is presented. Results are presented of a technoeconomic analysis of a wood pyrolysis to gasoline process based on experimental work at the National Renewable Energy Laboratory, USA, and of a straw liquefaction to fuel oil process based on experimental work at Manchester University, UK. The potential for chemicals from biomass is also considered. A standard technoeconomic procedure was used for the analysis, with a plant size of 1 000 dry t/d biomass feed. Sensitivity cases covering feedstock costs, capital cost variation and plant capacity are also presented. (orig.)

0910 Properties and Composition

Refer also to citation(s) 6168

0920 Combustion

Refer also to citation(s) 4992, 6139, 6150, 6151, 6154, 6155, 6157, 6159, 6161

5538 (DOE/CE/15612–T2) **Combustion of municipal solid wastes with oil shale in a circulating fluidized bed. Quarterly report, quarter ending 31 December 1994.** Synfuels Engineering and Development, Inc., Arvada, CO (United States). [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-94CE15612. Order Number DE95005112. Source: OSTI; NTIS; GPO Dep.

The test plan is designed to demonstrate that oil shale co-combusted with municipal solid waste (MSW) can reduce gaseous pollutants (SO_2, CO) to acceptable levels (90%+ reduction) and produce a cementitious ash which will, at a minimum, be acceptable in normal land fills. The small-scale combustion testing will be accomplished in a 6-in. circulating fluid bed combustor (CFBC) at Hazen Research Laboratories. This work will be patterned after the study the authors conducted in 1988 when coal and oil shale were co-combusted in a program sponsored by the Electric Power Research Institute. The specific purpose of the test program will be to: determine the required ratio of oil shale to MSW by determining the ratio of absorbent to pollutant (A/P); determine the effect of temperature and resident time in the reactor; and determine if kinetic model developed for coal/oil shale mixture is applicable.

0930 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6122, 6152, 6153, 6158, 6160, 6163

0950 Environmental Aspects

Refer also to citation(s) 6156, 6161

5539 (VF-BIO–94-7) **External noise when using biofuel.** Kotaleski, J. Vattenfall Utveckling AB, Vaellingby (Sweden). Aug 1994. 119p. (In Swedish). Project Bioenergy-UB93-844. Order Number DE95723966. Source: OSTI; NTIS; INIS.

The aim of this study has been to cover sources of noise dealing with all steps in a biofuel chain; producing, transporting, storing and firing the biofuel. When the availability of relevant test results from noise surveys is not so good and mostly badly documented, the study has been concentrated on estimation of external noise for planning and design purposes, from a prospective biofuel-fired plant. A synoptic tabulation of estimated acoustic power levels from different noise sources, has been done. The results from measurements of external noise from different existing combined power and heating plants are tabulated. The Nordic model for simulation of external noise has been used for a prospective plant - VEGA - designed by Vattenfall. The aim has been to estimate its noise pollutions at critical points at the nearest residential area (250 m from the fenced industry area). The software - ILYD - is easy to handle, but knowledge about the model is necessary. A requisite for the reliability is the access to measurements or estimations of different sources of noise, at different levels of octaves from 63 to 8000 Hz. The degree of accuracy increases with the number of broad band sources, that are integrated. Using ILYD with available data, a night limit of 40 dB(A) should be possible to fulfill with good degree of accuracy at VEGA, between 10 pm and 7 am, with good planning and under normal operation conditions. A demand for 35 dB(A) as a limit can be harder to fulfill, especially at mornings from 6 to 7. Noise from heavy vehicles within the plant area is classified as industrial noise and not as road traffic noise. This type of noise depends very much on the way of driving and assumed acceleration. Concerning wheel-mounted loaders, they may then only be used during daytime. The simulations show, that even at daytime from 7 to 6 pm, it would be possible to use an acoustically damped chipping machine, inside the power industry area. 31 refs, 13 figs, tabs, 8 appendices

5540 (VF-BIO–94-10) **Forest fuel and sulphur.** Lundborg, A. Vattenfall Utveckling AB, Vaellingby (Sweden). Oct 1994. 64p. (In Swedish). Project Bioenergy-38402-03. Order Number DE95723967. Source: OSTI; NTIS; INIS.

This report illustrates the sulphur cycle in forest fuel and in the forest ecosystem. The hypothesis is that sulphur dioxide from combustion of forest fuel is not more acidifying than sulphur that is mineralized from tree biomass if it is left in the forest instead of being burnt. The report gives an overview of the sulphur cycle in general together with the acidifying effect of sulphur. The sulphur content in wood biomass is about 1 mg/g in the needles and 0.2-0.3 mg/g in wood. Chipped forest fuel contains 0.2-0.5 mg S/g. A removal of 40 tonnes of felling residues per hectare may contain about 8-30 kg S. The sulphur occurs both in organic, often reduced, form and as sulphate. In situations of high availability to sulphur there will be an increased proportion of sulphate. After combustion some, perhaps half, of the sulphur is left in the ashes, most of which appears to be sulphate. In mineralisation of reduced organic sulphur, of type R-SH, the sulphur is released in the form of sulphide. Hydrogen sulphide, H2S, can be oxidised by microbes to sulphate, which should be acidifying (2 H+ will remain). A very rough estimate suggests that emissions of sulphur dioxide from forest fuel, spread over the period the trees are growing, and on the area from which the trees are taken, corresponds to 0.5% of the sulphur deposition in southern Sweden. Sulphur emissions from biofuel combustion are much lower than Sweden's and the EU's most stringent emission limits for coal. Whole-tree removal with return of ashes will theoretically give a considerable reduction in soil acidity since large quantities of nitrogen are removed and thus the acidifying effect of nitrogen will not occur. This should be of greater importance for forest acidification than the effect of biomass sulphur. 80 refs, numerous tabs.

5541 (VF-BIO–94-11) **Forest fuel and carbon balances.** Lundborg, A. Vattenfall Utveckling AB, Vaellingby (Sweden). Oct 1994. 55p. (In Swedish). Project Bioenergy-38402-03. Order Number DE95723968. Source: OSTI; NTIS; INIS.

Forest fuel, i.e., branches and tops that remain after felling, are not considered to give a net surplus of carbon dioxide to the atmosphere. In order to, if possible, verify this theory a survey was made of the literature concerning different carbon flows related to forest fuel. Branches and needles that are not utilised as fuel nonetheless eventually become decomposed to carbon dioxide. Branches and stem wood are broken down in occasional cases to 60-80% already within 5-6 years but the decomposition rate varies strongly. A small amount of existing data suggest that branches and stems are broken down almost completely within 60-70 years,

and earlier in some cases. Lignin is the component in needles and wood that is the most resistant to decomposition. Decomposition is favoured by optimal temperature and moisture, ground contact and ground animals. Material that is mulched during soil preparation is decomposed considerably faster than material that lies on the soil surface. Felling residues that are left on the soil are a large momentary addition to the soil's reserves of organic material but after a number of years the difference in soil organic material is small between places where fuel has been removed and places where felling residues have been left. High nitrogen deposition, fire control and effective forestry are factors that contribute to the increases in the reserves of soil organic material. It appears to be a good approximation to consider the forest fuel as being a neutral fuel as regards carbon dioxide in a longer perspective. In comparison with other biofuels and fossil fuels, forest fuel appears, together with Salix, to be the fuel that results in very little extra discharge of carbon dioxide or other greenhouse gases during its production, transport and processing. 70 refs, 5 figs, tabs

0980 Waste Management

Refer also to citation(s) 4992

5542 (NEI-DK–1746) **Ammonia volatilization from pig slurry and concentrated anaerobic fermented slurry. Measured by a new micrometeorological mass-balance technique.** Tidsskrift for Planteavls Specialserie. Beretning, S2252. Gjedde Sommer, S. (Forskningscenter Foulum. Afd. for Planteernaering og -fysiologi, Tjele (Denmark)); Petersen, J. Statens Planteavlsforsoeg, Lyngby (Denmark). 1993. 27p. (In Danish). Order Number DE95723837. Source: OSTI; NTIS.

Ammonia volatilization was determined from pig slurry and concentrated anaerobic fermented slurry applied in the field. The slurry was surface applied on the crop canopy, drag hose applied on the soil beneath the crop or directly injected into the soil. Losses were determined by an atmospheric mass balance technique with passive NH_3-flux samplers. The slurry was applied to six squared plots (15 x 15m) situated in a winter wheat field. The experiments were conducted during two eight day periods in April and May to a 5-10 cm and 30-35 cm high winter wheat, respectively. The mass-balance technique was found to be well suited for this type of experiments. To avoid transfer of ammonia beteen the plots, distances between plots should be more than 50 m. Preferentially the plots should be placed in rows perpendicular to the wind direction. (au) (23 refs.)

10 SYNTHETIC FUELS

Refer also to citation(s) 6165

1002 Production

5543 (DOE/MC/29228–3936) **Selective methane oxidation over promoted oxide catalysts. Quarterly report, June–August, 1994.** Klier, K.; Herman, R.G.; Shi, C.; Sun, Q. Lehigh Univ., Bethlehem, PA (United States). Sep 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG21-92MC29228. Order Number DE95000029. Source: OSTI; NTIS; GPO Dep.

In the past quarter, progress has been made in the direct conversion of methane to methanol over promoted metal oxides catalysts using a double-layered catalyst bed reactor configuration with steam as cofeed. Research concentrated on finding a second layer catalyst that could efficiently trap methyl radicals and produce methanol. A variety of metal oxides have been explored, and the highest methanol yield, nearly 100 g/kg cat x hr along with other products including formaldehyde and C_2 hydrocarbons, was obtained over 1% V_2O_5/SiO_2 as the second bed catalyst at 600 C with CH_4/air/steam mixture and at a CH_4-to-air ratio of 1.5 and a GHSV of 72,000 l/kg cat x hr. Experiments were carried out to study the effects of total flow rate and bed size on the production of oxygenates. Increasing the total flow rates increased the space time yield (STY) of both methanol and formaldehyde, while at the same time the level of methane conversion was reduced. This effectively shifted the selectivity toward oxygenates and provided useful information for future reactor design. Experiments showed that the cofeed of steam with the reagent mixture was not only beneficial but also necessary for the production of methanol, particular when the ability of the second bed to activate methane was small.

5544 (DOE/PC/92114–T4) **Gasoline from natural gas by sulfur processing. Quarterly report No. 4, April 1994–June 1994.** Erekson, E.J.; Miao, F.Q. Institute of Gas Technology, Chicago, IL (United States). Jul 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92114. Order Number DE95004317. Source: OSTI; NTIS; GPO Dep.

This report presents the work performed at the Institute of Gas Technology (IGT) during the fourth program quarter from April to June 30, 1994, under Department of Energy (DOE) Contract No. DE-AC22-93PC92114. This program has coordinated funding for Task I from IGT's Sustaining Membership Program (SMP), while DOE is funding Tasks 2 through 8. Progress in all tasks is reported here. The overall objective of this research project is to develop a catalytic process to convert natural gas to liquid transportation fuels. The process, called the HSM (Hydrogen Sulfide-Methane) Process, consists of two steps that each use catalysts and sulfur-containing intermediates: (1) converting natural gas to CS_2 and (2) converting CS_2 to gasoline-range liquids. Some catalysts are known to catalyze the second step. Experimental data will be generated to facilitate evaluation of the overall commercial viability of the process. During this quarter, progress in the following areas has been made: (1) Five catalysts were prepared for the reaction of methane with hydrogen sulfide to produce carbon disulfide; (2) A total of one hundred twenty four tests were performed using four of these catalysts; (3) Conversion of methane to CS_2 was achieved with all four catalysts; (4) Two of the catalysts are not desirable because they also produced significant amounts of carbon and sulfur; (5) Methane conversion reached 100% at 1000°C and above; (6) The highest production rate of CS_2 was achieved with catalyst IGT-MS-105. The rate was 132 g CS_2 per kg cat-h, and the yield per pass was 98%. This far exceeds our target yield of 40%.

5545 (DOE/PC/92116–T3) **Superacid catalysis of light hydrocarbon conversion. DOE PETC third quarterly report, February 25, 1994–May 24, 1994.** Gates, B.C. Delaware Univ., Newark, DE (United States). Dept. of Chemical Engineering. [1995]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92116. Order Number DE95004323. Source: OSTI; NTIS; GPO Dep.

Environmental concerns are leading to the replacement of aromatic hydrocarbons in gasoline by high-octane-number branched paraffins and oxygenated compounds such as methyl t-butyl ether. The ether is produced from methanol and isobutylene, and the latter can be formed from n-butane by isomerization followed by dehydrogenation. Paraffin isomerization reactions are catalyzed by very strong acids such as aluminum chloride supported on alumina. The aluminum chloride-containing catalysts are corrosive, and their disposal is expensive. Alternatively, hydroisomerization is catalyzed by zeolite-supported metals at high temperatures, but high temperatures do not favor branched products at equilibrium. Thus there is a need for improved catalysts and processes for the isomerization of n-butane and other straight-chain paraffins. Consequently, researchers have sought for solid acids that are noncorrosive and active enough to catalyze isomerization of paraffins at low temperatures. For example, sulfated zirconia catalyzes isomerization of n-butane at temperatures as low as 25°C. The addition of iron and manganese promoters has been reported to increase the activity of sulfated zirconia for n-butane isomerization by three orders of magnitude. Although the high activity of this catalyst is now established, the reaction network is not known, and the mechanism has not been investigated. The goal of this work is to investigate low-temperature reactions of light paraffins catalyzed by solid superacids of the sulfated zirconia type. The present report is concerned with catalysis of n-butane conversion catalyzed by the Fe- and Mn- promoted sulfated zirconia described in the previous report in this series.

5546 (DOE/PC/92116–T4) **Superacid catalysis of light hydrocarbon conversion. DOE PETC fourth quarterly report, May**

25, 1994–August 24, 1994. Gates, B.C. (Univ. of California, Davis, CA (United States)). Delaware Univ., Newark, DE (United States). Dept. of Chemical Engineering. [1995]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC92116. Order Number DE95004306. Source: OSTI; NTIS; GPO Dep.

The primary goal of this project is to evaluate the potential value of solid superacid catalysts of the sulfated zirconia type for light hydrocarbon conversion. The key experiments include testing of the performance of such catalysts in a flow reactor fed with streams containing, for example, n-butane or propane. A solid superacid catalyst was prepared by addition of iron and manganese to sulfated zirconium hydroxide followed by calcination. The catalyst was tested for n-butane conversion in a packed-bed flow reactor at temperatures of 40 to 225°C with the reactant partial pressure in the range of 0.0025-0.01 attn. The predominant catalytic reaction was n-butane isomerization, and this was accompanied at 40°C by near stoichiometric disproportionation. The C3/C5 molar ratio was generally greater than 1, consistent with conversion of the secondary C5 products. As the temperature increased, the selectivity for isomerization decreased and that for disproportionation increased. In a typical experiment the activity of the catalyst increased for about 1 h on stream and then declined rapidly. The rate maxima as a function of time on stream were taken as a measure of the initial activity of the catalyst. For example, the approximate rate of isomerization of n-butane at the maximum was 4.3 x 10-8 mol/(g of catalyst · s) with a feed n-butane partial pressure of 0.0025 atm at 75°C. With a feed n-butane partial pressure of 0.005 atm at 40°C and a conversion of 1 1%, the molar ratio of propane to i-butane was 0.03, and with the same feed composition at 100°C, this ratio at a conversion of 50% was 0.1. The iron- and manganese-promoted solid superacid catalyst is potentially of value for practical low-temperature paraffin isomerization accompanied by disproportionation of n-butane.

5547 (DOE/PC/92117–T10) **Bioconversion of coal derived synthesis gas to liquid fuels. Quarterly technical progress report, July 1, 1994–September 30, 1994.** Jain, M.K.; Worden, R.M.; Grethlein, A. Michigan Biotechnology Inst., Lansing, MI (United States). 14 Oct 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC92117. Order Number DE95004315. Source: OSTI; NTIS; GPO Dep.

The objective of this project is to develop an integrated two-stage fermentation process for conversion of coal-derived synthesis gas to a mixture of alcohols. This is achieved in two steps. In the first step, Butyribacterium methylotrophicum converts carbon monoxide (CO) to butyric and acetic acids. Subsequent fermentation of the acids by Clostridium acetobutylicum leads to the production of butanol and ethanol.

13 HYDRO ENERGY

1301 Resources and Availability

Refer also to citation(s) 5514

1305 Economic, Industrial and Business Aspects

Refer also to citation(s) 5548

1306 Environmental Aspects

5548 (DOE/EA–0999) **Proposal to market Provo River Project power, Salt Lake City area.** USDOE Western Area Power Administration, Salt Lake City, UT (United States). Salt Lake City Area Office. [1995]. 18p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004411. Source: OSTI; NTIS; INIS; GPO Dep.

This report is an environmental assessment of the Western Area Power Administrations's proposal to change the way in which the power produced by the Provo River Project (PRP) is marketed. The topics of the report include the alternatives to the proposed action that have been considered, a description of the environmental consequences of the proposed action and the alternatives that were considered, and other environmental considerations.

5549 (TVA–95003298) **Aquatic Plant Management Program current status and seasonal workplan.** Burns, E.R.; Bates, A.L.; Webb, D.H. Tennessee Valley Authority, Muscle Shoals, AL (United States). Aquatic Biology Dept. Jul 1993. 73p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003298. Source: OSTI; NTIS.

The objective of the TVA Aquatic Plant Management Program is to support in an environmentally and economically responsible manner, the balanced multiple uses of the water resource of the Tennessee Valley. This is accomplished by following an integrated approach to prevent introduction and spread of noxious species, documenting occurrence and spread of existing species, and suppressing or eliminating problems in designated high use areas. It is not the TVA objective, nor is it biologically feasible and prudent to eliminate all aquatic vegetation. Aerial photography, helicopter reconnaissance, and field surveys are used to assess distributions and abundance of various aquatic macrophytes. Water level fluctuations are supplemented by herbicide applications to control undesirable vegetation. Investigations are conducted to evaluate water level fluctuation schemes, as well as biological, mechanical, and alternative chemical control techniques which offer potential for more environmentally compatible and cost-effective management operations.

5550 (TVA/WM–93/14) **Convective circulation during differential heating and cooling in the Minky Creek embayment of Guntersville Reservoir, data summary for 1991.** Smith, C.S. (Army Engineer Waterways Experiment Station, Vicksburg, MS (United States)); James, W.F.; Barko, J.W. Tennessee Valley Authority, Chattanooga, TN (United States). Jun 1993. 50p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003305. Source: OSTI; NTIS.

Convective circulation patterns were examined in the Minky Creek embayment of Guntersville Reservoir, Alabama, during Mid-august to mid-October 1990 and mid-May through mid-November 1991. This report describes the results obtained during 1991. Day time heating produced a warm surface layer at all stations, while the layer was often eliminated during nighttime cooling. For much of the study period, vertical temperature stratifications was minimal except during periods of heating or cooling. During differential heating, shallow regions were aften heated to the bottom while warming was confined to surface layers at deeper locations. During differential cooling water moved from shallow regions as an underflow of cool water and was replace by a return current of warmer surface waters from deeper regions. Wind influence the temperature gradients. These results support the contention that convective circulation can potentially be very important in reservoir embayments.

5551 (TVA/WR–92/28) **Chickamauga reservoir embayment study - 1990.** Meinert, D.L.; Butkus, S.R.; McDonough, T.A. Tennessee Valley Authority, Chattanooga, TN (United States). Div. of Water Resources. Dec 1992. 346p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003299. Source: OSTI; NTIS.

The objectives of this report are three-fold: (1) assess physical, chemical, and biological conditions in the major embayments of Chickamauga Reservoir; (2) compare water quality and biological conditions of embayments with main river locations; and (3) identify any water quality concerns in the study embayments that may warrant further investigation and/or management actions. Embayments are important areas of reservoirs to be considered when assessments are made to support water quality management plans. In general, embayments, because of their smaller size (water surface areas usually less than 1000 acres), shallower morphometry (average depth usually less than 10 feet), and longer detention times (frequently a month or more), exhibit more extreme responses to pollutant loadings and changes in land use than the main river region of the reservoir. Consequently, embayments are often at greater risk of water quality impairments (e.g. nutrient enrichment, filling and siltation, excessive growths of aquatic plants, algal blooms, low dissolved oxygen concentrations, bacteriological contamination, etc.). Much of the secondary beneficial use of

reservoirs occurs in embayments (viz. marinas, recreation areas, parks and beaches, residential development, etc.). Typically embayments comprise less than 20 percent of the surface area of a reservoir, but they often receive 50 percent or more of the water-oriented recreational use of the reservoir. This intensive recreational use creates a potential for adverse use impacts if poor water quality and aquatic conditions exist in an embayment.

14 SOLAR ENERGY

Refer also to citation(s) 6071

1401 Resources and Availability

5552 (EGG–11265-1075) **Thermal radiant exitance model performance: Soils and forests.** Balick, L.K. (EG&G Energy Measurements Inc., Las Vegas, NV (United States)); Smith, J.A. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-9409265–1: European symposium on satellite remote sensing, Rome (Italy), 26-30 Sep 1994). Order Number DE95003619. Source: OSTI; NTIS; GPO Dep.

Models of surface temperatures of two land surface types based on their energy budgets were developed to simulate the effects of environmental factors on thermal radiant exitance. The performance of these models is examined in detail. One model solves the non-linear differential equation for heat diffusion in solids using a set of submodels for surface energy budget components. The model performance is examined under three desert conditions thought to be a strong test of the submodels. The accuracy of the temperature predictions and submodels is described. The accuracy of the model is generally good but some discrepancies between some of the submodels and measurements are noted. The sensitivity of the submodels is examined and is seen to be strongly controlled by interaction and feedback among energy components that are a function of surface temperature. The second model simulates vegetation canopies with detailed effects of surface geometry on radiant transfer in the canopy. Foliage solar absorption coefficients are calculated using a radiosity approach for a three layer canopy and long wave fluxes are modeled using a view factor matrix. Sensible and latent heat transfer through the canopy are also simulated using, nearby meteorological data but heat storage in the canopy is not included. Simulations for a coniferous forest canopy are presented and the sensitivity of the model to environmental inputs is discussed.

1403 Economic, Industrial, and Business Aspects

5553 (INIS-mf–13967) **A computer model for a multistage adiabatic methanator.** Levy, M. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Physics); Levitan, R.; Rosin, H.; Rubin, R. Weizmann Inst. of Science, Rehovoth (Israel). Jan 1991. 14p. Contract 90-05 25/90-1-85. Order Number DE94628357. Source: OSTI; NTIS (US Sales Only); INIS.

The purpose of this work is to analyze the performance of a multistage catalytic methanator, using a computer model. (authors). 10 tabs.

5554 (INIS-mf–13968) **Design of a CO_2-CH_4 reformer for a 100 Kw parabolic dish solar concentrator.** Steinfeld, A. (Weizmann Inst. of Science, Rehovoth (Israel)); Segal, A.; Levy, M. Weizmann Inst. of Science, Rehovoth (Israel). Jan 1991. 6p. Contract 90-05 25/90-1-85. Order Number DE94628358. Source: OSTI; NTIS (US Sales Only); INIS.

Design of a CO_2-CH_4 reformer. A schematic diagram of the system components is shown. (authors). 1 fig.

5555 (SAND–94-2910C) **Tax barriers to solar central receiver generation technology.** Jenkins, A.F. (California Energy Commission, Sacramento, CA (United States)); Reilly, H.E. Sandia National Labs., Albuquerque, NM (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–14: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95004537. Source: OSTI; NTIS; GPO Dep.

Tax loads and required revenues are estimated for current and future solar central receiver and gas-fired plants competing in the same market. An economic measure of tax equity is used to evaluate the equity of the tax loads under past and present tax codes. The same measure is used to devise a tax strategy which produces the following two types of equitable taxation: (1) the two plants carry nearly equal tax loads, and (2) local, state and federal governments receive the same distribution of revenues from the solar plant as from the gas-fired plant 'Me results show that central receivers (and likely other capital-intensive technologies) carry higher tax loads compared to competing gasfired generation, that tax loads are highly correlated with competitiveness, and that equitable taxation is feasible within the boundaries of the study.

1405 Solar Energy Conversion

Refer also to citation(s) 5513, 5520

5556 (DOE/ER/13631–T2) **Photochemical energy conversion by membrane-bound photoredox systems. Final report.** Tollin, G. Arizona Univ., Tucson, AZ (United States). Dept. of Biochemistry. 16 Jun 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-86ER13631. Order Number DE95004405. Source: OSTI; NTIS; GPO Dep.

This project has received DOE support since July 1, 1978. During this period, 40 papers have been published dealing predominantly with chlorophyll-photosensitized electron transfer reactions in a variety of media (solutions, polymer films, lipid bilayer membranes). The overall theme of this work has been to develop mechanistic strategies f or photochemical energy storage via chlorophyll, using the green plant photosynthetic system as a paradigm for designing in vitro systems. Microheterogeneous lipid vesicle suspensions allow ready application of time-resolved optical spectroscopy to follow the course of light-induced electron transfer processes. Both the yields and the lifetimes of electron transfer products were markedly improved in the vesicle systems. In subsequent studies, this compartmentalization was favorably manipulated by controlling the electrical charge on the membrane surface, by controlling the solubility properties of the acceptors, by varying the lipid composition, by using mediators to create a concentration gradient to carry electrons from within the bilayer to the aqueous medium, and by incorporating secondary electron acceptors into the aqueous phase.

5557 (ETDE/DE-mf–95733316) **Investigations on the conditions for the crucible-free growth of silicon ribbons for solar cells at high pulling speeds. Final report.** Thieme, W. Institut fuer Kristallzuechtung im Forschungsverbund Berlin e.V. (IKZ) (Germany). Apr 1993. 51p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0329324A. Order Number DE95733316. Source: OSTI; NTIS (US Sales Only).

The pulling of silicon ribbons without crucibles and dies from a threadlike molten zone with an inclined growing interface could allow high pulling velocities, and, because of the absence of any foreign material near the hot region, to grow a good crystal quality, similar to the float zone process. Newer considerations and computer simulations have shown that a cylindrical mirror furnace can be used to concentrate a radiation field around the working focus line, suitable for this purpose. The optically concentrated radiation field can be laid out by variations of some parameters of the mirror furnace in such a form, that the disstribution of the radiation density is able to create a threadlike molten zone with a wedgeshaped cross-section. This shaped molten zone can be used as the liquid source for the ribbon growth process with a growing interface nearly parallel to the pulling direction. (orig./BWI)

5558 (NEI-FI–248, pp. 9-20) **Solar hydrogen energy: number 7 in the world energy supply heptagon.** Winter, C.J. (German Aerospace Research Establishment, Stuttgart (Germany)). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel

cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

The traditional primary energy economy is inherently oriented toward increasing the energy supply. It must give way to an end energy economy oriented toward decreasing the demand for energy. An end energy economy for the emerging Second Solar Civilization uses, besides the four traditional energies coal, oil, gas, and nuclear energy, increasingly the three 'new' energies efficient energy conversion and use, on-site solar energy and solar hydrogen in a HEPTAGON of world energy supply which is closer to being a closed loop, requires fewer energy raw materials in favour of more technology and financial investment, and is more environmentally responsible. Solar hydrogen can perpetuate the world's energy trade system beyond the time when the fossil system will have come to an end. In 1991 the Fraunhofer-Institut fuer Systemtechnik und Innovationsforschung and Prognos published an analysis of whether and under which conditions solar hydrogen would be consistent with the traditional energy infrastructure in the decades to come. The main conclusion reads, 'Assuming that by the middle of the next century it will be necessary to reduce CO_2 emissions more than 60 %, the development of a hydrogen economy is not only consistent with the call for an energy supply which is as economical as possible. Such CO_2 reduction goals even mandate the utilization of these technologies.'

5559 (NEI-FI–248, pp. 31-32) **A solar hydrogen pilot-system with pressurized alkaline electrolyzer and PAFC fuel cell.** Lund, P. (Helsinki Univ. of Technology, Otaniemi (Finland). Dept. of Technical Physics); Vanhanen, J.; Kauranen, P. Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

Short communication SOLAR POWER PLANTS/hydrogen storage; LEAD-ACID BATTERIES; SOLAR CELL ARRAYS; ELECTROLYSIS; PHOTOVOLTAIC CELLS; PILOT PLANTS; ENERGY STORAGE; ALKALINE ELECTROLYTE FUEL CELLS; SOLAR ENERGY CONVERSION

5560 (NREL/TP–410-7408) **NREL Photovoltaic Program FY 1994 bibliography.** National Renewable Energy Lab., Golden, CO (United States). Dec 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000275. Source: OSTI; NTIS; GPO Dep.

This report lists all published documents of the Photovoltaic Program for FY 1994. Documents include conference papers, journal articles, book chapters, patents, etc.

5561 (SAND–94-2399) **1993 annual final progress report: July 1992 through June 1993.** Rohatgi, A. (Georgia Inst. of Tech., Atlanta, GA (United States). School of Electrical and Computer Engineering); Crotty, G.; Chen, Z.; Sana, P.; Salami, J.; Doolittle, A.; Pang, A.; Pham, T. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 316p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004272. Source: OSTI; NTIS; GPO Dep.

This is the first annual report since the Inauguration of the University Center of Excellence for Photovoltaics Research and Development (UCEP) at Georgia Tech. The essential objective of the Center is to improve the fundamental understanding of the science and technology of advanced PV devices and materials, to provide training and enrich the educational experience of students in the field, and to increase US competitiveness by providing guidelines to industry and DOE for achieving cost-effective and high efficiency PV devices. These objectives are to be accomplished through a combination of research and education. This report summarizes the technical accomplishments, including modeling, processing, and characterization of cast multicrystalline silicon solar cells; use of modeling and PCD measurements to develop a road map for progressing toward 20% multicrystalline and 25% single crystalline cells; the development of a novel PECVD SiN/SiO_2 AR coating that also provides good surface passivation; PECVD deposited SiO_2 films with record low S and D_{it} at the SiO_2/Si interface; and educational activities and accomplishments.

1406 Photovoltaic Power Systems

Refer also to citation(s) 5560, 5998, 6098

5562 (ETDE/DE-mf–95726947) **Design, construction and tests of an alternative power supply system for the utilisation of renewable resources. Final report.** Bucher, W. (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany). Managementdienste-Energietechnik (MD-ET)). Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Koeln (Germany). Managementdienste-Energietechnik (MD-ET). Dec 1992. 42p. Order Number DE95726947. Source: OSTI; NTIS (US Sales Only).

The German Ministry for Science and Technology allocated funds for an experimental task to assess the feasibility of solar and wind application for the island Fernando de Noronha as a cooperative German/Brazilian endeavour. The paper presents the highlights of the tasks performed, describing the equipment, the activities and measurements undertaken, and summarizing the results. (BWI)

5563 (ETDE/DE-mf–95733348) **Photovoltaic pilot and demonstration project in Schleswig-Holstein, additional power supply for the tunnel lighting system of the street tunnel under the Kiel Canal at Rendsburg. Final report.** Maass, K.; Muehle, H. Deutsche Aerospace AG, Wedel (Germany). Fachgebiet Solartechnik. Oct 1993. 147p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0328967A. Order Number DE95733348. Source: OSTI; NTIS (US Sales Only).

In 1991 a 70.5 kWp photovoltaic solar generator was added to the lighting system of the street tunnel under the Kiel Canal at Rendsburg, which represented an attractive pv application: The consumption of the lighting system corresponds to the outdoor illumination conditions, and thus pv generated power is directly used to a high degree. The variation of lighting power is necessary to overcome the adaptation problems of the human eye when the driver enters from daylight into the dark tunnel tube. Photovoltaic power for tunnel lighting could be demonstrated convincingly. (orig.)

5564 (ETDE/DE-mf–95733388) **Performance of a photovoltaic solar cell generator for active power and reactive power input into power suply grids. Final report.** Fachhochschule Hannover (Germany). Fachbereich Elektrotechnik. 23 Oct 1992. 28p. (In German). Sponsored by Niedersaechsisches Ministerium fuer Wissenschaft und Kultur, Hannover (Germany). Order Number DE95733388. Source: OSTI; NTIS (US Sales Only).

Investigations of a photovoltaic generator are reported. The solar cell surface of 20 m^2 was divided into 4 fields, each containing 12 solar cell modules. The solar cell modules generate a maximum electric power of 2.1 kW in the form of d.c. voltage, which is converted into a.c. voltage. (HW)

5565 (NEI-FI–248, pp. 51-58) **The planning of a 5 kW_p photovoltaic - hydrogen energy system.** Eriksson, S. (Chalmers Univ. of Technology, Goeteborg (Sweden)); Carlsson, P. Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

The main aim of our project is to develop, build and test a solar energy system that can deliver electric energy 24 hours a day during a large part of the year. Solar energy is the only abundantly available source of flowing energy, but to use it effectively an efficient collector of the inflowing energy and a storage medium to compensate for the fluctuations in the flow is necessary. We wish to increase the knowledge on the use of photovoltaics as the energy collector and hydrogen as the storage medium in a solar energy system used in Scandinavian climate. The main aim of our project can be divided into the following parts: Building a well functioning system, developing a computerized system for monitoring and control, formulate safety regulations for solar-hydrogen energy systems, optimizing system efficiency and reliability, analysing and minimizing the cost of energy production and testing of new components and techniques

5566 (NEI-FI–248, pp. 59-69) **Design and system technology of autonomous renewable H_2 systems.** Vanhanen, J. (Helsinki Univ. of Technology, Otaniemi (Finland)). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage*. 166p. Order Number DE95723907. Source: OSTI; NTIS.

The solar hydrogen is a promising alternative for photovoltaic energy storage. The first commercial applications may be small self-sufficient solar hydrogen systems for remote power applications. A self-sufficient solar hydrogen system consisting of a photovoltaic array, a battery, an electrolyzer, a fuel cell and a load. The system design of solar hydrogen energy system requires a numerical simulation model which can be used for system sizing an component interfacing studies. H2PHOTO is a user-friendly and accurate simulation program for-solar hydrogen systems which have been verified against experimental data from the solar hydrogen pilot plant of Helsinki University of Technology.

1407 Solar Thermal Power Systems

Refer also to citation(s) 5555, 5587

5567 (ETDE/DE-mf–95726973) **Development, construction and testing of two metal membrane solar concentrators with Stirling energy converter, each with a capacity of 50 kW. Final report.** Benz, R.; Schiel, W.; Friedl, W.; Schlaich, J. Schlaich Bergermann und Partner, Stuttgart (Germany). 1987. 156p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 03E8247A. Order Number DE95726973. Source: OSTI; NTIS (US Sales Only).

The aim of the project was the planning, the development, the construction, testing and operation of two membrane solar concentrators with Stirling energy converters. The project had the following results among other things: 1. The system is distinguished by good efficiency, adaptability and low development cost. 2. Even large and very large concentrators can be constructed without great investment cost on site. 3. The Stirling energy converters also had good results under extreme service conditions and weather conditions. 4. The tracking and control occured with electronic systems. 5. The losses of the receiver should be decreased even further. 6. The possibility of the reliable supply of an isolated grid could be demonstrated. 7. The second part of the project (operating phase) unfortunately was not as successful. (orig./HW)

5568 (NREL/TP–471-7017) **Combined-cycle power tower.** Bohn, M.S.; Williams, T.A.; Price, H.W. National Renewable Energy Lab., Golden, CO (United States). Oct 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950336–4: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95000218. Source: OSTI; NTIS; GPO Dep.

This paper evaluates a new power tower concept that offers significant benefits for commercialization of power tower technology. The concept uses a molten nitrate salt centralreceiver plant to supply heat, in the form of combustion air preheat, to a conventional combined-cycle power plant. The evaluation focused on first commercial plants, examined three plant capacities (31, 100, and 300 MWe), and compared these plants with a solar-only 100-MWe plant and with gas-only combined-cycle plants in the same three capacities. Results of the analysis point to several benefits relative to the solar-only plant including low energy cost for first plants, low capital cost for first plants, reduced risk with respect to business uncertainties, and the potential for new markets. In addition, the concept appears to have minimal technology development requirements. Significantly, the results show that it is possible to build a first plant with this concept that can compete with existing gas-only combined-cycle plants.

5569 (NREL/TP–471-7019) **Solar thermal electric hybridization issues.** Williams, T.A.; Bohn, M.S.; Price, H.W. National Renewable Energy Lab., Golden, CO (United States). Oct 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950336–3: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95000217. Source: OSTI; NTIS; GPO Dep.

Solar thermal electric systems have an advantage over many other renewable energy technologies because the former use heat as an intermediate energy carrier. This is an advantage as it allows for a relatively simple method of hybridization by using heat from fossil-fuel. Hybridization of solar thermal electric systems is a topic that has recently generated significant interest and controversy and has led to many diverse opinions. This paper discusses many of the issues associated with hybridization of solar thermal electric systems such as what role hybridization should play; how it should be implemented; what are the efficiency, environmental, and cost implications; what solar fraction is appropriate; how hybrid systems compete with solar-only systems; and how hybridization can impact commercialization efforts for solar thermal electric systems.

5570 (SAND–94-0657C) **An examination of metal felt wicks for heat-pipe applications.** Adkins, D.R. (Sandia National Labs., Albuquerque, NM (United States)); Moss, T.A.; Andraka, C.E.; Andreas, N.H.; Cole, H.M. Sandia National Labs., Albuquerque, NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–6: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95002608. Source: OSTI; NTIS; GPO Dep.

Precision metal felts are made of filaments of microndiameter wires that are chopped and layered onto a flat surface to form a wool-like material. Metal felts are commonly used as filters for micron-sized particles. The small diameters of the wires and the relatively open structure of these non-woven materials provide porosities on the order of 90% and greater. The high porosities of metal felts make them interesting candidate materials for heat pipe applications. Property measurements on selected samples of metal felts have demonstrated that typical effective pore radii range from 40 to 120 μm and the respective Darcy permeabilities range from 30 to 300 μm^2. Through careful compaction of these materials, it is possible to tailor the flow characteristics of the materials to specific applications. Recently, a series of tests have been conducted at Sandia to measure the flow characteristics and pore structures of these materials as a function of compaction. Results from these tests and a discussion of the current applications of these materials in liquid-metal heat pipes for solar power conversion systems are presented in this paper.

5571 (SAND–94-1839C) **Co-validation of three methods for optical characterization of point-focus concentrators.** Wendelin, T.J. (National Renewable Energy Lab., Golden, CO (United States)); Grossman, J.W. Sandia National Labs., Albuquerque, NM (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–2: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95001613. Source: OSTI; NTIS; GPO Dep.

Three different methods for characterizing point-focus solar concentrator optical performance have been developed for specific applications. These methods include a laser ray trace technique called the Scanning Hartmann Optical Test, a video imaging process called the 2f Technique and actual on-sun testing in conjunction with optical computer modeling. Three concentrator test articles, each of a different design, were characterized using at least two of the methods and, in one case, all three. The results of these tests are compared in order to validate the methods. Excellent agreement is observed in the results, suggesting that the techniques provide consistent and accurate characterizations of solar concentrator optics.

5572 (SAND–94-2555C) **Investigation of cold filling receiver panels and piping in molten-nitrate-salt central-receiver solar power plants.** Pacheco, J.E.; Ralph, M.E.; Chavez, J.M.

Sandia National Labs., Albuquerque, NM (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–15: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95004534. Source: OSTI; NTIS; GPO Dep.

Cold filling refers to flowing a fluid through piping or tubes that are at temperatures below the fluid's freezing point. Since the piping and areas of the receiver in a molten-nitrate salt central-receiver solar power plant must be electrically heated to maintain their temperatures above the nitrate salt freezing point (430°F, 221°C), considerable energy could be used to maintain such temperatures during nightly shut down and bad weather. Experiments and analyses have been conducted to investigate cold filling receiver panels and piping as a way of reducing parasitic electrical power consumption and increasing the availability of the plant. The two major concerns with cold filling are: (1) how far can the molten salt penetrate cold piping before freezing closed and (2) what thermal stresses develop during the associated thermal shock. Cold fill experiments were conducted by flowing molten salt at 550°F (288°C) through cold panels, manifolds, and piping to determine the feasibility of cold filling the receiver and piping. The transient thermal responses were measured and heat transfer coefficients were calculated from the data. Nondimensional analysis is presented which quantifies the thermal stresses in a pipe or tube undergoing thermal shock. In addition, penetration distances were calculated to determine the distance salt could flow in cold pipes prior to freezing closed.

5573 (SAND–94-2776C) **Recent results on the optical performance of solar two heliostats.** Jones, S.A.; Edgar, R.M.; Houser, R.M. Sandia National Labs., Albuquerque, NM (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–12: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95004536. Source: OSTI; NTIS; GPO Dep.

Recent Sandia support of the Solar Two project has included the analysis of optical performance issues related to heliostat field improvements. Two types of heliostats will be used for the Solar Two project: The 1818 original 38.4 m^2 Martin Marietta Co. heliostats, and 108 new 95 m^2 Lugo heliostats. Carrisa Plains mirror modules will be used to construct the Lugo heliostats and refurbish original heliostats. Baseline, clean reflectivity measurements of 0.90 and 0.94 are recomended for the original heliostat and the Carrisa Plains modules, respectively. Sandia's Beam Characterization System provided beam quality information for representative configurations of both heliostats. This showed that the replacement of two facets with Carrisa Plains modules on an original heliostat led to a slight increase in spillage, but also increased beam power. As expected, the large beam of the Lugo heliostat showed poorer beam quality and significant spillage, but proved to be an economical addition of reflective area. The Carrisa Plains modules were found to be nominally flat, although the focal length changed slightly with temperature. An analysis of the canting options for both types of heliostats was performed. It was recommended the original heliostats be canted with an on-axis, lookback method, whereas a two-step method using first on-, then off-axis approaches was recommended for the Lugo heliostats. Finally, measurements performed at the Daggett site showed that despite the 1992 Landers earthquake, heliostat pedestal tilt and the associated tracking errors are expected to be within acceptable limits.

5574 (SAND–94-2909C) **Evaluation of power production from the solar electric generating systems at Kramer Junction: 1988 to 1993.** Kolb, G.J. Sandia National Labs., Albuquerque, NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–11: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95004530. Source: OSTI; NTIS; GPO Dep.

The five Solar Electric Generating Systems (SEGS) at Kramer Junction, California, now have nearly 30 years of cumulative operating experience. These 30 MW plants employ parabolic trough technology originally deployed by LUZ International in the late 1980's and are now managed, operated and maintained by the Kramer Junction Company. In this paper, Sandia National Laboratories performed an analysis of the annual energy production from the five plants. Annual solar-to-electric conversion efficiencies are calculated and the major factors that influenced the results are presented. The generally good efficiencies are primarily attributed to the excellent equipment availabilities achieved at all plants.

1409 Solar Thermal Utilization

Refer also to citation(s) 6098

5575 (DOE/CH/10093–350) **Sunspace basics.** National Renewable Energy Lab., Golden, CO (United States). Nov 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000296. Source: OSTI; NTIS; GPO Dep.

FS-124.

Anyone who lives in a home with a sunspace will tell you that the sunspace is the most enjoyable room in the house. Many times the homeowner's only regret is that the sunspace is not larger. Although aesthetics often drive the decision to add a sunspace or include one in a new home design, sunspaces can also provide supplemental space heating and a healthy environment for plants and people. In fact, a well-designed sunspace can provide up to 60% of a home's winter heating requirements. This publication addresses basic elements of sunspace design; design considerations for supplemental space heating, growing plants, and use as a living space; design guidelines including siting, heat distribution, and glazing angles; and major sunspace components including glazing options, thermal mass, insulation, and climate controls. A list of sources for more information is also provided.

5576 (DOE/SF/16306–44) **Colorado State University program for developing, testing, evaluating and optimizing solar heating and cooling systems: Project status report for the months of October and November, 1994.** Colorado State Univ., Fort Collins, CO (United States). Solar Energy Applications Lab. Dec 1994. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG36-86SF16306. Order Number DE95004299. Source: OSTI; NTIS; GPO Dep.

This report describes a project to develop tools for evaluating solar heating and cooling systems. Current work on this project has been to validate the Florida Solar Energy Center's (FSEC) models of the Solahart 302K and 302K-AS systems to prepare a rating for the Sacramento Municipal Utility District's rebate program for solar domestic hot water heaters. A preliminary rating has been issued by FSEC and updated ratings will be released as necessary. Two of the problems that were mentioned in the August/September report are addressed and a tank heat loss test is discussed. Work continues on improving and validating the models.

5577 (DTU-LV-MEDD–265) **Daylight walls.** Boye-Hansen, L. Danmarks Tekniske Univ., Lyngby (Denmark). Lab. for Varmeisolering. Sep 1994. 45p. (In Danish). Contract EM-22411-401-05-01. Order Number DE95723843. Source: OSTI; NTIS.

EFP-84.

Heat loss through external walls is proportional to the number of degree hours calculated, using the temperature difference from wall surface to wall surface. It was investigated to what extent transmission heat loss could be reduced by using opaque 'daylight' walls, which are lightweight walls heavily insulated with opaque insulation materials with exterior transparent insulation (a single layer of glass or other transparent material).To enhance the use of direct and diffuse radiation the outer surface of the opaque wall is painted black. Temperatures on and through three glazed walls of a small test hut were monitored. Measured air and surface temperatures and weather data were used to calculate the number of degree hours for the opaque daylight walls and for traditional highly insulated walls. Energy savings and the consequences on indoor thermal comfort of using daylight walls were analyzed using the simulation

programme tsbi3. A detached rectangular house was used as a model to be compared with a similar house with daylight walls. Energy savings were found as the difference in heating demands between the two houses and thermal comfort was analyzed in both houses. Measurements at the test hut showed that maximum reduction in degree hours was 35-75% at a south facing wall during sunny periods. In cloudy weather reduction was 8%. For the houses with daylight walls, monthly savings in heating energy was 3-31% and 3-79%. The analysis of thermal comfort showed no significant influence from the use of daylight walls. (AB)

5578 (DTU-LV-MEDD–269) **Solar wall as energy diode.** Vejen, N.K.; Blaagaard, G. Danmarks Tekniske Univ., Lyngby (Denmark). Lab. for Varmeisolering. Oct 1994. 44p. (In Danish). Contract ENS-51181-92.0064. Order Number DE95723841. Source: OSTI; NTIS.

In connection with the renovation of older buildings, interest in using solar energy in solar walls is growing. The use of solar walls can help to reduce energy consumption and also help to protect the outer walls, which they cover, from the ravages of the weather - thus saving on maintenance costs. The solar energy can preheat the ventilation air. The aim of the project was to develop a combination of extra insulation and a solar wall - a solar wall energy diode. The building's ventilation system sucks in air through an absorber made of mineral wool so that energy from the absorber is transferred to the ventilation air which is thus heated. When the sun shines on the solar wall the mineral wool is warmed, when it doesn't, the energy diode functions as a countercurrent insulation and part or all of the heat loss from the rooms through the wall is absorbed by the air and carried back to the house as preheated ventilation air. This means that solar heat is led into the building and the loss of energy through the walls is reduced. A mathematical model and a calculation programme for the analysis of the solar energy diode are presented. A simulation for the evaluation of the solar energy diode's significance with regard to the indoor climate for the whole building is also given in addition to an economical evaluation of the use of this system. It was found that this ventilated solar wall had a greater capacity than a more traditional form of after-insulation. (AB)

5579 (DTU-LV-MEDD–270) **Test of the solar boiler system from Thermo Dynamics Ltd.** Furbo, S. Danmarks Tekniske Univ., Lyngby (Denmark). Lab. for Varmeisolering. Nov 1994. 32p. Order Number DE95723863. Source: OSTI; NTIS.

The Solar Boiler system, which is a small DHW solar heating system marketed by the Canadian company Thermo Dynamics Ltd, was investigated. The system makes use of both the drain back principle and the low flow principle. The heat from the solar collector loop is transferred to the domestic water of the hot water tank by means of an external heat exchanger. A flexible so-called 'life-line', which is used as the solar collector loop of the system facilitate the installation. The components of the system were earlier tested in indoor test facilities. The efficiency of the solar collector was measured in the solar simulator test facility of the Thermal Insulation Laboratory. The 'life-line' was investigated theoretically as well as experimentally in a test facility for heat storages. The hot water tank and the heat exchanger were tested in the heat storage test facility was well. The solar heating system was tested side-by-side with five marketed Danish and one Dutch solar heating systems under realistic conditions in a test facility for small DHW heating systems. The thermal performance of the system can therefore be compared to the thermal performances of the Danish and Dutch systems. Based on the investigations the suitability of the system is estimated for Danish conditions. (au)

5580 (ETDE/DE-mf–95726890) **Solar promotion primer for solar thermal plants in residential buildings. The promotion of solar thermal plants in residential buildings in Hesse.** Ministerium fuer Umwelt, Energie und Bundesangelegenheiten des Landes Hessen, Wiesbaden (Germany). Apr 1994. 55p. (In German). Order Number DE95726890. Source: OSTI; NTIS (US Sales Only).

Years after their introduction on the market, solar thermal plants for the heating of sewage and reservoir water are comparatively small spread, although they border on the profitability with the present energy price level. The presented program aims at the application of solar thermal plants in residential building construction, in business and in the public area. The program partly combines existing support possibilities of the country. A detailed information is given about the program. In addition, the responsible authorities for national support of solar plants are mentioned. (BWI)

5581 (ETDE/DE-mf–95733293) **Production and characterization of optical components for active and passive solar thermal applications. Final report.** Graf, W.; Koehl, M.; Wittwer, V. Fraunhofer-Institut fuer Solare Energiesysteme (ISE), Freiburg im Breisgau (Germany). [1992]. 57p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0329029A. Order Number DE95733293. Source: OSTI; NTIS (US Sales Only).

The present research project was part of a coordinated project aimed at developing highly efficient spectral-selective layers for solar absorbers manufactured by means of physical coating processes, especially high-vacuum cathodic sputtering. Within the framework of the described project the measuring technology needed for optical characterization was designed and made available, and already existing equipment for the resistance tests was complemented. Furthermore, appropriate test procedures were developed, and the solar absorbers were tested. Additionally, the development of layers was supported by means of a laboratory sputtering appliance. (orig./HW)

5582 (INIS-mf–13910) **Chemical reactions in a solar furnace. 2. Direct heating of a vertical reactor in an insulated receiver. Methanation of CO/H_2 and of reformer products.** Weizmann Inst. of Science, Rehovoth (Israel). Oct 1989. 99p. Contract 89-1-85. Order Number DE94628355. Source: OSTI; NTIS (US Sales Only); INIS.

Methanation experiments were carried out with a mixture of H_2 and CO and with the product mixture resulting from the reforming experiments in a vertical tubular reactor in the solar furnace. These results will be the basis for our planned closing of the loop and testing the complete cycle. A computer program was developed to simulate the reforming experiments out in the vertical reactor. The calculations include the concentration and redistribution of sunlight, the heat transfer into the the reactor and the heat absorption by the chemical reaction. The results of the calculations showed good agreement with the experimental results. The computer program, after some modifications, will be used for the calculations and the design of a larger reformer to be operated in the solar tower. These results were summarized in a form of a manuscript entitled.

5583 (INIS-mf–13910, pp. 35, Paper 1) **Chemical reactions in a solar furnace. 2. Direct heating of a vertical reactor in an insulated receiver. Experiments and computer simulations.** Levy, M. (Weizmann Inst. of Science, Rehovoth (Israel). Dept of Physics); Levitan, R.; Meirovitch, E.; Segal, A.; Rosin, H.; Rubin, R. Weizmann Inst. of Science, Rehovoth (Israel). Oct 1989. Sponsored by Ministry of Energy and Infrastructure, Jerusalem (Israel). Contract 89-1-85. In *Chemical reactions in a solar furnace. 2. Direct heating of a vertical reactor in an insulated receiver. Experiments and computer simulations. Methanation of CO/H_2 and of reformer products.* 99p. Order Number DE94628355. Source: OSTI; NTIS (US Sales Only); INIS.

The performance of a solar chemical heat pipe was studied using CO_2 performing of methane as the endothermic reaction. A directly heated vertical reactor, packed with a Rh catalyst was used. The solar tests were carried out in the Schaeffer solar furnace of the Weizman Institute of Science. Power absorbed was up to 6.4 Kw, flow rates of the gases reached 11000 l/h and the methane conversions reached 84%. A computer model was developed to simulate the process. Agreement of the calculations with the experimental results was quite satisfactory. (author). 6 refs., 3 tabs., 20 figs.

5584 (INIS-mf–13910, pp. 62, Paper 2) **Methanation of CO/H_2 and of reformer products.** Levy, M. (Weizmann Inst. of Science, Rehovoth (Israel). Dept. of Physics); Rosin, H.; Levitan, R.; Rubin, R. Weizmann Inst. of Science, Rehovoth (Israel). Oct 1989. Sponsored by Ministry of Energy and Infrastructure, Jerusalem (Israel). Contract 89-1-85. In *Chemical reactions in a solar furnace. 2.*

Direct heating of a vertical reactor in an insulated receiver. Experiments and computer simulations. Methanation of Co/H_2 and of reformer products. 99p. Order Number DE94628355. Source: OSTI; NTIS (US Sales Only); INIS.

The pilot methanation system was built in the Solar Furnace in order to investigate the chemical reaction kinetics and yield. Optimization was achieved.

5585 (NEI-DK–1745) **Measurement and evaluation of the solar heating system at Hjoernegaarden.** Balslev-Olesen, O. Cenergia ApS, Ballerup (Denmark). Oct 1994. 20p. (In Danish). Contract ENS-51181-92.0037. Order Number DE95723842. Source: OSTI; NTIS.

In connection with the renovation of the boiler room and the roof in a block of flats at Hjoernegaarden, Roskilde, a solar heating system was installed for space and water heating. The area of the solar collector is 144 square meters for 43 flats so that each flat has a larger area of solar collector than is normally found. The collector is mounted on a south-facing roof surface slanting at an angle of 45 degrees. degrees and it supplies a storage tank with a volume of 10 cubic meters located in the boiler room down in the cellar. The solar heating system is connected to the building's heating and domestic water plants but it is the solar heating system that primarily heats the domestic water supply, though it is also used to supplement the space heating during the spring and autumn months. The design and and results of measurements taken over a period of one year are presented. (AB)

5586 (NEI-DK–1752) **Small hot water containers that can be used as a stand-by within a solar heating system. Guidelines for dimensioning.** Oestergaard Jensen, S. Dansk Teknologisk Inst., Taastrup (Denmark). Proevestationen for Solenergi. Sep 1994. 43p. (In Danish). Contract ENS-51181-92.0058. Order Number DE95723854. Source: OSTI; NTIS.

With the help of a computerized simulation programme, a small hot water container for use in houses was dimensioned. The aim was to design a cheap and simple facility which, within a solar heating system heating system, could be used as a container where a supplementary heat source, in the form of hot water, could be added at the top. Two heat storage concepts were investigated, one was for use in connection with a smaller gas-fired boiler involving small heat losses, which meant that it would not be necessary to shut down the boiler in the summer, and the other was for use in connection with boilers involving large heat losses where it is necessary to shut down the boiler during the summer and use an electric cartridge located in the upper part of the storage facility as the source of supplementary heat. The guidelines for the dimensioning of these types of heat storage facilities are presented in detail. (AB)

5587 (NEI-FI–248, pp. 23-29) **The PV/Hydrogen system of the self-sufficient solar house.** Stahl, W. (Fraunhofer-Institut fuer Solare Energisysteme, Freiburg (Germany)). Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

The Fraunhofer Institute for Solar Energy Systems is demonstrating for the first time in Germany, that a solar house can operate completely independently of other forms of energy. The institute has developed and demonstrated transparent insulation systems as a means of efficient utilization of solar radiation for space heating. Together with a highly efficient collector system based on transparent insulation for domestic hot water, and a photovoltaic generator in conjunction with a hydrogen/oxygen storage system, energetic self-sufficiency is achievable. Planning of the Self-Sufficient Solar House (SSSH) began in 1988, the start of the construction was in June 1991 and completion was in October 1992. A three-year period of measurements in the occupied building with 145 m^2 living area will follow. Since no conventional energy sources will be used, this house will operate without emitting any pollution. The intention of the project is to show the technical potential of solar energy to replace all environmentally damaging energy carriers in a dwelling. The demonstration of the technical potential is the basis for clarifying the economic potential. Many of the technologies and components to be applied in the SSSH will find their way into commercial application under the aspect of sustainable development in the future. This paper concentrates on the PV/Hydrogen-System of the SSSH. A detailed description of the building with all components will be published.

5588 (NREL/TP–471-7294) **Flux attenuation at NREL's High-Flux Solar Furnace.** Bingham, C.E.; Scholl, K.L.; Lewandowski, A.A. National Renewable Energy Lab., Golden, CO (United States). Oct 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950336–9: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95000219. Source: OSTI; NTIS; GPO Dep.

The High-Flux Solar Furnace (HFSF) at the National Renewable Energy Laboratory (NREL) has a faceted primary concentrator and a long focal-length-to-diameter ratio (due to its off-axis design). Each primary facet can be aimed individually to produce different flux distributions at the target plane. Two different types of attenuators are used depending on the flux distribution. A sliding-plate attenuator is used primarily when the facets are aimed at the same target point. The alternate attenuator resembles a venetian blind. Both attenuators are located between the concentrator and the focal point. The venetian-blind attenuator is primarily used to control the levels of sunlight failing on a target when the primary concentrators are not focused to a single point. This paper will demonstrate the problem of using the sliding-plate attenuator with a faceted concentrator when the facets are not aimed at the same target point. We will show that although the alternate attenuator necessarily blocks a certain amount of incoming sunlight, even when fully open, it provides a more even attenuation of the flux for alternate aiming strategies.

5589 (NREL/TP–472-7295) **Barriers to solar process heat projects: Fifteen highly promising (but cancelled) projects.** Carwile, C. (USDOE, Washington, DC (United States). Office of Industrial Technologies); Hewett, R. National Renewable Energy Lab., Golden, CO (United States). Oct 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950336–10: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95000221. Source: OSTI; NTIS; GPO Dep.

We analyzed technical, economic, and institutional barriers encountered by the solar industry in penetrating the market of solar thermal systems as applied in industry, commerce, and government. The barriers discussed are not theoretical or developed by conducting marketing research surveys of potential users. Rather, they are barriers that precluded implementing actual solar projects for 15 "highly promising" prospective users. The efforts to determine their technical and economic feasibility were funded by the US Department of Energy (DOE) Solar Process Heat (SPH) program. Each year, the SPH program conducts a prefeasibility studies activity – an engineering assessment of the technical and economic feasibility of a solar system for a specific application for a specific end-user. These studies also assess institutional issues that impact the feasibility of the proposed project and develop an action plan for the project's implementation. In FY 1991 and FY 1992, the program funded a total of 11 studies in which solar projects were investigated for 21 potential users. Of these 21 potential users, only three have made firm commitments to acquire solar systems, yielding a 14% success rate (decisions by three other companies are still pending). The low success rate is disappointing because the solar companies had complete freedom to select "highly promising" potential users. We therefore evaluated the reasons for the low success rate and the implications for market penetration.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 5567, 5571, 5581, 5588

5590 (ETDE/DE-mf–95733393) **Development of absorbers for flat plate collectors. Final report.** Jaeger, H. Solvis Energiesysteme GmbH, Braunschweig (Germany). 30 Jul 1993. 17p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0329029D. Order Number DE95733393. Source: OSTI; NTIS (US Sales Only).

The performance of flat plate collectors is more or less a function of the energy conversion efficiency of the absorber. Problems concerning the economic and thermodynamic optimisation of absorbers are discussed. (orig./HW)

5591 (NEI-DK–1735) **Development of solar collectors mounted on roofs of steel.** Mikkelsen, P.; Katic, I. Dansk Teknologisk Inst., Taastrup (Denmark). Proevestationen for Solenergi. Sep 1994. 29p. (In Danish, Swedish). Contract ENS-51181-93.0054. Order Number DE95723833. Source: OSTI; NTIS.

The possibilities of using solar energy in connection with the renovation of roofs where steel units are laid on top of older asbestos cement sheets are investigated. Three prototypes of suitable solar collector designs are examined, and their capacities are compared with types of a more traditional design. Results showed that the capacity of collectors of a quite simple, newer, design compared well with that of traditional models when the absorbers of the former are integrated in the roof construction. This is because heat transfer from the steel roof lying under the collector reduces heat loss. It is difficult to achieve an acceptable temperature for domestic water heating based only on heat exchange between the warm air under the roof and a circulating fluid, where there is a a roof plate instead of a transparent covering over the absorber. At lower temperatures, for example in the case of heating systems for swimming pools, this design could be considered suitable. The solar collector will than be camouflaged and the absorber will be integrated as part of the roof surface. The suggested construction is aesthetically attractive, especially when compared to solar collectors mounted on top of the roof, and it is also cheaper than those of traditional design. It is concluded that this type of solar collector has good potentials for use in connection with roof renovation. (AB)

5592 (SAND–94-2638C) **Mirror alignment and focus of point-focus solar concentrators.** Diver, R.B. Sandia National Labs., Albuquerque, NM (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–7: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95002609. Source: OSTI; NTIS; GPO Dep.

Distributed point-focusing solar concentrators are being developed for dish-Stirling systems and other applications. Many of these concentrators make use of faceted mirrors that have to be accurately aligned. Some of the solar concentrator designs use stretched-membrane facets that also require focusing. Accurate mirror alignment and focus of faceted solar concentrators have two benefits. First, the concentration ratio of the concentrator/receiver (collector) system is improved with accurate alignment and focus. The receiver aperture diameter can therefore be smaller, thereby reducing thermal losses from the receiver and improving the overall efficiency of the collector. Second, and perhaps more importantly, flux intensities on the receiver can be sensitive to facet alignment and focus. In this paper, the theory and practical application of an alignment and focusing technique are presented. In the technique, light from an artificial source is reflected from the concentrator's facets to a target. From basic geometric principles, the shape and location of the reflected light on the target can be predicted. Alignment is accomplished by adjusting the facets aim so that the reflected image falls on the predetermined location. To focus a stretched-membrane facet, the reflected image size is adjusted to match that of the target. The governing equations used to draw the alignment targets are developed and the practical application of the technique to the alignment and focus of the Cummins Power Generation, Inc. CPG-460 are presented. Alignment uncertainty associated with this technique on the CPG-460 is also discussed.

5593 (SAND–94-2682C) **Felt-metal-wick heat-pipe solar receiver.** Andraka, C.E. (Sandia National Labs., Albuquerque, NM (United States)); Adkins, D.R.; Moss, T.A.; Cole, H.M.; Andreas, N.H. Sandia National Labs., Albuquerque, NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950336–13: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95004535. Source: OSTI; NTIS; GPO Dep.

Reflux heat-pipe receivers have been identified as a desirable interface to couple a Stirling-cycle engine with a parabolic dish solar concentrator. The reflux receiver provides power nearly isothermally to the engine heater heads while decoupling the heater head design from the solar absorber surface design. The independent design of the receiver and engine heater head leads to higher system efficiency. Heat pipe reflux receivers have been demonstrated at approximately 65 kW_t power throughput. Several 25 to 30-kW_e Stirling-cycle engines are under development, and will soon be incorporated in commercial dish-Stirling systems. These engines will require reflux receivers with power throughput limits reaching 90-kW_t. The extension of heat pipe technology from 60 kW_t to 100 kW_t is not trivial. Current heat pipe wick technology is pushed to its limits. It is necessary to develop and test advanced wick structure technologies to perform this task. Sandia has developed and begun testing a Bekaert Corporation felt metal wick structure fabricated by Porous Metal Products Inc. This wick is about 95% porous, and has liquid permeability a factor of 2 to 8 times higher than conventional technologies for a given maximum pore radius. The wick has been successfully demonstrated in a bench-scale heat pipe, and a full-scale on-sun receiver has been fabricated. This report details the wick design, characterization and installation into a heat pipe receiver, and the results of the bench-scale tests are presented. The wick performance is modeled, and the model results are compared to test results.

1420 Heat Storage

Refer also to citation(s) 5586

15 GEOTHERMAL ENERGY

1502 Geology and Hydrology of Geothermal Systems

Refer also to citation(s) 5004

5594 (ETDE/JP-mf–95730258) **Verification of geothermal exploration technology in fiscal 1991. Development of fracture reservoir exploration (development of exploration with seismic wave /development of exploration).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1992. 180p. (In Japanese). Order Number DE95730258. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

An effective exploration technology is to be newly developed in order to accurately explore the fault group which controls the fluid flow in the geothermal reservoir. Taking the past progress in study into consideration, the result in fiscal 1991 was reported. Yutsubo geothermal field in Oita Prefecture was selected as an experimental site. In the high-accuracy seismic reflection method with both P-wave and S-wave hypocenters, reflection events which were good in S/N ratio were obtained down to the depth of about 1.5sec in two-way travel time. Discontinuous reflection events judged to be a fracture were discriminated from the S-wave reflection recorded in profile. As a result of seismic wave propagation test, the initial motion of S-wave was clearly observed also by vertical seismic profiling (VSP). The reflection method is sufficiently effective in generally grasping the fracture structure. In a P-wave's zero offset VSP, the reflected wave from the boundary between lava and tuff was clearly detected with a reflection surface which corresponded well to that recorded in logging. Pursuable as a continuous horizon in the imaging record, the reflection surface can serve as a reliable index to detect the fracture. 80 figs., 4 tabs.

5595 (ETDE/JP-mf–95730259) **Verification of geothermal exploration technology in fiscal 1991. Development of fracture reservoir exploration (development of exploration with seismic wave) /total evaluation of well boring, logging, borehole test and fracture characteristics.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1992. 222p. (In Japanese). Order Number DE95730259. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

An effective exploration technology is to be newly developed in order to accurately explore the fault group which controls the fluid flow in the geothermal reservoir. Taking the past progress in study into consideration, the result in fiscal 1991 was reported. A 1705m deep N3-YT-2 wellhole was bored in the Yutsubo area in Hohi geothermal field selected as an experimental site. The geological order of stratification was analyzed a well survey made with physical logging inside the borehole. A water injection test was conducted to grasp the relation between the water permeability and fracture characteristics of the strata around the borehole. In the past reports, assumed was the existence of three fracture systems as a model, i.e., NW-SE trending macro-scale one, E-W trending meso-scale one which accorded in direction with the active fault, and local small-scale one. However, the present borehole did not encounter the main fracture system which formed a presently active hydrothermal passage. Possibly, it might do the small-scale fracture. In the seismic exploration, clear reflection events were confirmed in the boundary between Narukogawa volcanic breccia and Kotobaki lava, and between Hachobaru lava and Pre-Kusu altered volcanic rock, and on the top surface of Hachobaru lava. 8 refs., 34 figs., 20 tabs.

5596 (ETDE/JP-mf–95730260) **Verification of geothermal exploration technology in fiscal 1992. Development of fracture reservoir exploration (development of exploration with electromagnetic wave /development of array CSMT).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 138p. (In Japanese). Order Number DE95730260. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

An array CSMT exploration technology is to be newly developed in order to accurately explore the fault group which relates to the geothermal reservoir. The array CSMT is an MT with an artificial signal source as well as stations laid in array along the traverse line. The result in fiscal 1992 was reported. Measurement was made possible by automatically switching the frequency as per the time schedule fixed in advance with a transmitter/receiver in the unit which was built in fiscal 1991 and presently modified. Software improvement was also made in the processing of two-dimensional inversion analysis data by the present method jointly with the MT. Notwithstanding an area which was comparatively high in noise level, good data were acquired through an application test in the Sengan area where the existence of geothermal reservoirs was confirmed. That area was known to be structured of three strata, i.e., high-resistivity stratum on the shallow subsurface, remarkably low-resistivity one on the medium subsurface and medium-resistivity one on the deep subsurface. Several low-resistivity zones were detected which indicated the geothermal alternation, and fairly reflected the fracture system structure and altered zone. 13 refs., 32 figs., 7 tabs.

1503 Geothermal Exploration and Exploration Technology

Refer also to citation(s) 5005, 5006, 5594, 5595, 5596, 5625, 5626, 5628, 6356, 6462, 6464, 6635, 6636, 6637

5597 (CONF-9405258–) **Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.** Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The 90th(Spring of fiscal 1994) SEGJ Conference was held in Tokyo during May 25-27, and a total of 120 papers were reported. As for bore hole survey, presented were behavior of a subsurface fracture reopening by crosshole triaxial seismic measurement and sonic log, analysis of fractures along a borehole axis at a geothermal well, etc. As to seismic tomography, reports were made on fracture characterization in volcanic regions - technology development on seismic tomography, seismic traveltime tomography in anisotropic media, etc. Concerning hypocenter/survey systems, the following were reported: ability of a new seismic source 'Seismic Shotpipe,' development of a new type receiving system for seismic prospecting in shallow layer, etc. In addition, a lot of papers were presented on ground vibration, tsunami disasters, temperature/reservoir, resistivity survey theory, electric/electromagnetic survey case study, MT method case study, archaeological prospecting/GPR, reflection method data processing, etc.

5598 (CONF-9405258–, pp. 1-6) **Characterization of drilling noise as seismic source for inverse VSP by means of downhole triaxial measurement.** Yoshida, T. (Tohoku University, Sendai (Japan). Faculty of Engineering); Asanuma, H.; Niitsuma, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Seismic wave emitted due to the well drilling was characterized in order to technologically develop a simplified and low-cost method of measuring the subsurface seismic wave. A triaxial seismic wave detector was installed at the depth of 206m in a measurement downhole horizontally about 120m distant from the well which was being drilled in East Hachimantai Field and at the depth of 191m in a measurement downhole horizontally about 200m distant from that in Technical Center Test Field of Japan National Oil Corporation. Seismic wave was measured due to rotary type tricone drilling. As a result in each of both fields, the main sonic source was known to be the bit with prevailing energy of S-wave. However, the seismic wave emitted from the bit was not clearly directive. As for the relativity among all modes, solely observed was strong relativity between both SV and SH components. No other was observed at all. Consequently, a model in which the main axis of drilling noise agreed in direction with the vibration of S-wave was prepared, so that the seismic wave was made characterizable due to the well drilling. 5 refs., 8 figs., 1 tab.

5599 (CONF-9405258–, pp. 36-40) **Ultrasonic borehole televiewer applicability to soft rock deep well.** Ikeda, R. (National Institute for Disaster Prevention, Tsukuba (Japan)); Omura, K.; Ujo, S.; Okabe, T.; Takasugi, Ss.; Plessmann, J.; Schepers, R. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The applicability of the BHTV logging under the following well conditions was discussed using the well (2,046 m in depth) drilled in Yokohama city for crustal movement observation purpose: As the well wall consisted of porous soft rock, it gave a low acoustic impedance. In addition, the muddy water which had a high absorption of ultrasonic wave was used. Although the conventional BHTV logging system (an ultrasonic wave image treatment system scanning with 1.5 MHz ultrasonic beam) had a high resolution. Decreasing the frequency to reduce the attenuation of ultrasonic wave due to the muddy water can cause the decrease in resolution. The results of BHTV logging on the well using the ultrasonic wave of 1.5 MHz and 500 KHz indicated the presence of continuous breakout in the range between 1500 m and 2000 m depth. The quality of logging data obtained by 500 KHz ultrasonic wave was better than those by 1.5 KHz. 7 refs., 6 figs.

5600 (CONF-9405258–, pp. 51-52) **Fracture characterization in volcanic region. Concepts and results obtained at Hohl.** Ishii, Y. (National Institute for Environmental Studies., Tsukuba (Japan)); Kinbara, K.; Asakura, N. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The tomography experiment made on two wells (depth: 1700m) which were apart from each other by about 270 meters in the experimental field in Yutsubo, Oita Prefecture was reported. This study is one of the 'Fracture Project' of NEDO. The purpose of this study was to determine the potentiality of utilizing the tomography as for the underground investigation method in the volcanic region. The tool design for practical use was not included in this study. The elastic wave was employed because of a long distance of observation. In order to operate smoothly the receiving system in a high temperature well, a sort of Dewar bottle was used for protecting the electronic parts from the heat. All efforts were thoroughly tried to reduce the S/N ratio. The experimental results agreed well with those obtained in the VSP. The tomograph velocity distribution in two wells well corresponded to the acoustic layer investigation results. 3 figs.

5601 (CONF-9405258–, pp. 53-56) **Fracture characterization in volcanic regions. Technology development on seismic tomography.** Asakura, N. (Japan Petroleum Exploration Co. Ltd., Tokyo (Japan)); Ishii, Y.; Muraoka, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

This paper reports the results of the elastic wave tomography test done in Yutsubo, Oita Prefecture. The test aimed at the verification of effectiveness of tomography among wells in a volcanic zone and the development of receiving system in high temperature geothermal wells. The test equipment consisted of three-components receiver with geophone sensor. It was able to carry out the measurement up to 260°C. The multi-level system was characterized by being able to get four data at one time. A new receiving system was developed by combining these devices. The emission/reception of signals were performed within a pair of wells which were apart from each other by about 270 meters at the depth from 700 to 1700 meters at intervals of 20 meters. The data with very low S/N ratio were obtained together with about 1600 wave lines. The velocity tomograph made of the obtained data was well compared with the acoustic logging results obtained in the two walls. The discrepancy in the two methods was within 5 %. 2 refs., 2 figs., 1 tab.

5602 (CONF-9405258–, pp. 57-62) **Fracture characterization in volcanic regions. Technology developments on pressure transient analysis.** Nakagome, O. (Japan Petroleum Exploration Co. Ltd., Tokyo (Japan)); Ishii, Y.; Yoneda, Y. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The technology development on pressure transient analysis done by using two adjacent wells in Yutsubo, Oita Prefecture was reported. This study was made as a part of the 'Fracture Characterization in Volcanic Regions' project of NEDO. It was assumed that the fracture zone was located below the depth of 1600 meters. Two wells were used for the test, i. e., one for active well, and the other for observation well. The water injection test was made by changing stepwise the water injection rate from 96 to 303 l/min. The air pulse test was also made by changing periodically the air pressure in the wells. The obtained data were analyzed. The results were as follows: No remarkable pressure response suggesting the presence of a large scale fracture was observed, though the two wells were connected with each other at the volcanic rock layer below 1500 m depth. It was estimated that the reservoir layer laying between the two wells consisted of small scale network fracture groups. The parameter values on the reservoir layer obtained by the air pulse test and by the water injection test were agreed with each other, proving the effectiveness of the air pulse test. 1 ref., 6 figs., 1 tab.

5603 (CONF-9405258–, pp. 166-170) **Ability of a new seismic source 'SEISMIC SHOTPIPE'.** Wada, Y. (OYO Corp., Tokyo (Japan)); Yamamoto, M. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the ability of newly developed 'SEISMIC SHOTPIPE'. Its overall length is 115cm. As a vibrating source for the seismic survey, it generates the elastic wave by driving the iron core downward with electromagnetic coil in the pipe (3.6cm in outer diameter) and firing the blank shot (explosive amount of 6g) with its explosion center struck. Its following ability was known through several repetitions of seismic survey with the above vibrating source: as judged from its velocity amplitude, it is equivalent in velocity energy to about one half to one sixth of the dynamite weighing 10g. In case of refracted wave, its readable reach of initial undulation is about 200m and several tens of meters in the wet ground and dry ground, respectively. The surveyable depth is about 30m and several tens of meters by the refraction method and reflection method, respectively. The frequency of generated wave is normally about 70 to 100Hz. Depending upon conditions, slightly higher frequencies of about 200Hz will be hopefully obtainable. 2 refs., 7 figs.

5604 (CONF-9405258–, pp. 171-174) **Development and field example of new type receiving system for seismic prospecting in sallow layer.** Yokota, H. (Hanshin Consultants Co. Ltd., Osaka (Japan)); Noda, T. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the receiving system newly developed for the seismic prospecting in the shallow layer. That system is composed of receiving part, vibrating part (self-traveling) and recording part. That receiving part is integrated by fitting both receivers and signal cable on a chemical fiber belt. Those receivers are easy to put on the belt and take off it with an arbitrary setting of interval between adjacent ones. Immediately after setting a vibrating source at the specified spot and recording the vibrating data, the reception section is shifted with the receiving part pulled by the recording car, so that the labor can be saved for the installation and recovery of both receivers and signal cable. As a result of S-wave reflection survey with the present system on a road of simplified pavement with asphalt, the following was confirmed: the underground structure is clearly graspable down to the depth of about 30m. At the time of measurement, the receivers were not off the ground with a tensile stress generated on the overall length of belt. 4 figs., 3 tabs.

5605 (CONF-9405258–, pp. 179-183) **Logging system for water quality monitoring in deeper depth.** Sano, K. (OYO Corp., Tokyo (Japan)); Sano, M.; Anklovitch, D.; Ohashi, T.; Graziottin, F. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of*

Japan) Conference. Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports a logging system for the quality monitoring of deep water down to the depth of 800m. That system is composed of probe and on-land geologger, both of which are connected by a two-line coaxial cable. The probe is equipped with seven pressure proof sensors to measure the pressure, temperature, conductivity, pH, oxidation/reduction potential and dissolved quantity of oxygen together with the standard value of both pH and oxidation/reduction potential. The measured data are adjusted by temperature and pressure with a built-in CPU, and then, conveyed to the on-land geologger, which is a multi-purpose geologger produced and already commercially sold by OYO Corporation, and equipped with a measurement module newly developed. The measured number of data is reported to be 3000 per one time of logging. The change in both temperature and pH is also reported to be clearly graspable by the measurement with the probe being lowered at a speed of 3m/min. 5 figs., 1 tab.

5606 (CONF-9405258–, pp. 280-284) **Estimation of equilibrium formation temperature using temperature data of MWD.** Takai, K. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Osato, K.; Nakata, H.; Takasugi, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

As written in the following, the present paper explains how the geothermal equilibrium forming temperature was estimated by MWD (measurement while drilling): a comparison was made for an actual well among its well temperature estimated by a well temperature simulation called GEOTEMP2 during the mud water circulation, mud water discharge temperature recorded during the well drilling and well temperature measured by resident point thermometer. Judging from the above comparison, the GEOTHEMP2 is utilizable for the inversion program which estimates the geothermal equilibrium forming temperature. Developed by Takai et al. with a non-linear least square applied to a revised GEOTHEMP2, a furthered inversion program estimates the above temperature progressively depth by depth with a constant interval downward from the shallow level. That program was known to be highly convergent in calculation result regardless of initial model given, short in calculation time per depth required for the estimation and utilizable for the real-time estimation of geothermal equilibrium forming temperature during the well drilling. 2 refs., 7 figs.

5607 (CONF-9405258–, pp. 285-289) **Evaluation of curve-fitting method for estimating the formation temperature from logging data.** Hyodo, M. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Takai, K.; Takasugi, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper explains the curve-fitting method developed as a method to estimate the geothermal equilibrium forming temperature. In the present method, that temperature is estimated by obtaining, by non-linear lest square, the model parameter to minimize the sum of remainders squared between the temperature actually measured after a lapse of certain time from the stoppage of mud water circulation and that calculated on the basis of Middleton model, mathematical model of temperature equilibrium well. In the Horner's plotting method currently in general use, temperature recovery data during a long period of about 120h are required for estimating the geothermal equilibrium forming temperature. However in the curve-fitting method, it is confirmed from the actual well data that the well recovery temperature is estimable from three logging data during 24h after the stoppage of mud water circulation within the largest error of 5%, and during 12h within 10%. 7 refs., 5 figs., 1 tab.

5608 (CONF-9405258–, pp. 290-294) **Temperature profile/bottom pressure monitoring system utilizing optical fiber and capillary tube. Field test in a geothermal well.** Osato, K. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Takasugi, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The following is reported about the well temperature profile/bottom pressure monitoring system with an optical fiber type temperature sensor inserted into a pressure observing capillary tube: the present system has the advantage of minimizing the damage to the optical fiber during the well operation by covering the outside of temperature sensor with anti-corrosive alloy and enabling the conventional pressure measurement only by connecting it with the existing pressure gauge. As a result of field test on the present system suspended in a geothermal well during about 3.5 months, it was known that the damage is slight to the optical fiber and that the optical loss is within the limits of hardly influencing the measurement. Therefore, the present system will be possibly applied to the long-term continuous observation. As a result of further study to heighten the measuring accuracy by changing the number of data additions in the measuring environment of actual well, their appropriate number was known to be roughly 32 to 128. 2 refs., 5 figs.

5609 (CONF-9405258–, pp. 295-298) **Fluid flow monitoring by electrical prospecting. Three dimensional inversion of SP data.** Hashimoto, K. (Kyushu University, Fukuoka (Japan). Faculty of Engineering); Tanaka, T.; Mizunaga, H.; Ushijima, K.; Kaieda, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper introduces an example of having estimated, by three-dimensional spontaneous potential (SP) analysis, the direction of fluid flow propagated underground due to the hydraulic crushing. A visualization method was developed by Hashimoto et al. on the concept that the fluid flow potential is the factor most closely related to the change in SP in the hydraulic crushing process. That method consists sequentially of considering the anomaly of SP to be attributable to the virtual point sources, estimating the location of sources by three-dimensional inversion analysis, and then, three-dimensionally visualizing the direction of fluid flow propagated underground. That method was applied to the SP differential profile obtained from data by fluid flow potential method during a hydraulic crushing test in Iidate Area, Fukushima Prefecture. As a result, negative sources and positive sources (tips of fluid flow) were visually shown to be distributed in the vicinity of crushed well and far from it, respectively together with the positive distribution zone extended in a certain specific direction with a progress made in crushing. 5 refs., 7 figs.

5610 (CONF-9405258–, pp. 309-314) **Study of effective electrode array of resistivity method.** Suzuki, K. (Central Research Institute of Electric Power Industry, Tokyo (Japan)). Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Two-pole array, dipole-dipole array and current convergence array were selected as an electrode array for the exploration by resistivity. Each of the above arrays was designed to be optimized in electrode arrangement. The resistivity profile was obtained, by BPT

(back projection technique) analysis, of the model in which a spherical conductor existed at four spots in homogeneous ground under the traverse line. As a result, its accuracy was high in case of synthesizing the result in both dipole-dipole array and current convergence array. However with noise added and heightened in level, the accuracy was so extremely lowered that the resultant resistivity structure finally became entirely different from the original one. A further result is also exhibited of evaluating the data measured in each of the two-pole array and dipole-dipole array during the basic experiment on a 30m traverse line with a 50mA current transmitted. 4 refs., 4 figs., 2 tabs.

5611 (CONF-9405258–, pp. 315-319) **Sensitivity distribution for current focusing resistivity method.** Noguchi, K. (Waseda University, Tokyo (Japan). School of Science and Engineering); Sakamoto, D. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports an example of having studied the sensitivity distribution of current focusing electrode array for the resistivity survey. In a buried sphere model in which a high-resistivity sphere (The sensitivity ratio of sphere was infinite to the ground.) was buried in the homogeneous ground, the three-dimensional sensitivity distribution was calculated, by method of image, in each of both straight-line and cross-lines arrays of electrodes at the same interval between adjacent ones. The following is reported: both those arrays are less influenced in sensitivity by the superficial condition than all the other ones. With an increase in depth, the sensitivity rises and the cross-lines array gives a higher sensitivity than that done by the straight-line one at the same depth. Based on a two-dimensional model, the difference generated in apparent sensitivity distribution was obtained, by finite element method, between the case where a high-sensitivity structure existed below the low-sensitivity surface and that where it did not there. As compared with all the other electrode arrays, the current focusing one is shown to be the best in grasping the high-sensitivity anomaly caused by the above structure. 5 refs., 8 figs.

5612 (CONF-9405258–, pp. 325-329) **Rapid relaxation inversion two-dimensional MT data. Part 3. Application to some field data.** Yamane, K. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Takasugi, S.; Yoneda, Y. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

As reported by the present paper, the following improvement was made in a RRI applied to the software development of two-dimensional inversion analysis of MT and CSMT, which form a part of NEDO's project for the development of electromagnetic wave utilization prospecting: a regularization parameter proposed by Leonov was introduced to overcome adverse conditions in the inversion calculation. Existing information was taken in the inversion model. Each of the stations was so modified that the analysis could be made regardless of analysis frequency. Each of the foregoing items is explained. As a result of MT and CSMT surveys conducted in Sumikawa geothermal area, Akita prefecture, shown is the inversion analysis result of data obtained along two about 6km long traverse lines. In addition, it is written that the time required per one of those lines was 1.5sec for the analysis when the largest number of repetitions was 20. 5 refs., 12 figs.

5613 (CONF-9405258–, pp. 330-332) **Fundamental study on two-dimensional inversion for MT interpretation.** Hasegawa, N. (Kyoto University, Kyoto (Japan). Faculty of Engineering); Sassa, K.; Sugano, T. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports problems raised in a two-dimensional inversion developed with application of RRI for the MT interpretation. It is pointed out that the accuracy heightening of analysis result in the RRI is limited, because the change in horizontal electric or magnetic field is neglected in the Maxwell equation in the process of deriving the remainder between the impedance obtained from the measured data and that calculated from the inversion model. The model is modified by a least square with smoothing. For that smoothing, a second-order differential of model parameter in the vertical coordinates was particularly used against the peak resistivity (about 30ohm m at a depth of about 1000m) which appeared as a result of analyzing the horizontal two-layer ground simulated with structure of the first layer (200m in thickness and 10ohm m in resistivity) and second layer (100ohm m in resistivity). It is also written that the above peak appears dependently on the smoothing, and that the analysis is somehow improved in result by changing methods of smoothing. 5 refs., 6 figs.

5614 (CONF-9405258–, pp. 333-337) **Is 3-D electrical survey needed.** Sasaki, Y. (Kyushu University, Fukuoka (Japan). Faculty of Engineering). Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The three-dimensional electrical survey is explained as follows: that survey is conceived to be inclusive of rough survey and accurate survey. The rough survey is made in order to confirm whether the underground structure is one-dimensional, two-dimensional or three-dimensional as an objective, while the accurate survey is limited in objective domain. The following result was obtained from the numerical simulation of three-dimensional survey with a borehole for the three-dimensional model in which plural heterogeneous bodies were contained in a homogeneous hemi-infinite medium: the three-dimensional inversion only with the surface data can reproduce the heterogeneous body existing on the shallow subsurface, but cannot do the low-resistivity body doing on the deep subsurface. If the number of measurement data is increased between the surface and borehole, the above low-resistivity body becomes reproducible. The present paper also shows an example of having assumed, by numerical simulation, the three-dimensional tomography in the domain surrounded with four boreholes. 9 figs.

5615 (CONF-9405258–, pp. 369-373) **Geoelectromagnetic investigation at Minamikayabe geothermal field in Hokkaido.** Mitsuhara, Y. (Geological Survey of Japan, Tsukuba (Japan)); Uchida, T. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the resistivity structure investigation by electromagnetic survey in Minamikayabe geothermal field in Hokkaido. To assess the result of array CSAMT survey (0.25Hz to 8kHz in frequency) investigated by the NEDO, a TEM survey (by which the underground resistivity structure was graspable from the measurement only of the magnetic field hardly affected by the static effect) was conducted by the geological survey office along the same 2km long traverse line laid from north to south in the above field. As a result of comparison between both the above surveys, the following was known: continuous low-resistivity strata striking with an eastward orientation from the west are taken notice of in the result of one-dimensionally analyzing the TEM data. In the result of one-dimensionally doing the CSAMT data, the almost

same structure as that given by the TEM data is confirmed however with a large influence of static effect and bad continuity of the above low-resistivity strata. They are improved in continuity by statically correcting the CSAMT data with the TEM data used. 9 refs., 13 figs.

5616 (CONF-9405258–, pp. 374-378) **CSMT and TDM survey in the Mori geothermal field, Hokkaido, North Japan.** Mogi, T. (Kyushu Univ., Fukuoka (Japan). Faculty of Engineering); Kajiwara, T.; Takahashi, M.; Ikeuchi, K.; Suzuki, I.; Nishimura, S.; Katsura, I.; Nishida, J.; Suzuki, K.; Kusunoki, I.; Matayoshi, S. Arsadi, E.; Jomori, A.; Shirai, N. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports both CSMT and TDEM surveys conducted to study the deep structure of caldera located in the central part of Mori geothermal field in the southwestern part of Hokkaido. At each station for the CSMT survey, two components of each of both magnetic and electric fields which were generated by an alternating transmission from both northwestern and southwestern transmitters were observed by detecting their 12 frequencies between 8.7kHz and 4.2Hz. Also for the TDTM survey, observation was made of about 150/10sec transient responses of vertical magnetic field to the rectangular reposing wave transmitted with a period of 64sec. The resistivity structure was obtained at each station from the joint inversion of invariant resistivity and phase by CSMT with the transient phenomenon curve of vertical magnetic field by DEM. As for the basic resistivity structure of the present geothermal field, the resistivity of its shallower strata, 2-3 km deep strata and deeper strata is higher than 30ohm m, lower than 10ohm m, and higher than 10ohm m respectively. 7 refs., 6 figs.

5617 (CONF-9405258–, pp. 379-383) **MT data processing using two sets of data acquired at the same site.** Kawakami, N. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Takasugi, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the test processing of data with two sets of acquired MT data. Both those sets (each of which was composed of five data components in their respective directions which were common to both sets) of data were acquired simultaneously at the same site. It is pointed out that both sets do not agree in time series data because the noise exists very locally, and that the long distance remote reference processing is not always effective in removing such a noise. The following sequence gave a good result of data processing: to divide both sets of data in the overall time zone of measurement by specified time zone (e.g., 2h by 2h). Based on the coherency of component in the same direction in each of the above specified time zones, to judge whether the data are to be used or not in each of those zones. To process the data in the selected zones by time series stacking, and in succession, long distance remote reference. 6 refs., 14 figs.

5618 (CONF-9405258–, pp. 384-388) **Magnetotelluric sounding at Bandai volcano. Part 1. Data acquisition system and data processing system.** Inoue, J. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Shiga, T.; Kawakami, N.; Takasugi, S.; Tanaka, K.; Takeuchi, M. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the observation method and data processing of an MT sounding (conducted by the National Research Institute for Earth Science and Disaster Prevention) in Bandai Volcano. Data in a wide band zone of 20kHz to 0.001Hz were acquired with an MT-1 system produced by EMI (USA) from 18 stations in array along an about 1.8km traverse line. The higher frequencies than 100Hz were analyzed by synchronous detection mode, while the lower ones than 100Hg were done through processing, by cascade decimation, their time series data acquired. It is written that the threshold giving the best result of analyzing the frequency was set in the cascade decimation by classifying the calculated power spectra into ranks by coherency threshold, and that the time series data were visually adjusted and recorded at several stations affected by the noise due to strong wind. 13 refs., 4 figs., 1 tab.

5619 (CONF-9405258–, pp. 389-393) **Magnetotelluric sounding at Bandai volcano. Part 2. Resistivity structure beneath the Bandai volcano.** Inoue, J. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Shiga, T.; Kawakami, N.; Takasugi, S.; Tanaka, K.; Takeuchi, M. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the result of an MT sounding conducted in Bandai Volcano in order to obtain information about the structure which caused the body collapse of mountain in 1888. Eighteen stations were laid in array along an about 1.8km long traverse line to traverse, from east to west, the main part around Numanotaira, crater of Bandai Volcano. The following is explained as a result of one-dimensionally analyzing the data acquired by TM mode: judging from the very harmonious distribution of both resistivity and phase in the sectional plan of both apparent resistivity frequency and phase frequency respectively, the resistivity distribution acquired by the present analysis gives the almost true one. High resistivity regions exist in deeper soil than 500 to 1000m below sea level, while low resistivity ones extend from the shallow subsurface downward to the deepest subsurface directly beneath Numanotaira. Such anomaly of resistivity is harmonious also with the result of both seismic and gravitational surveys conducted in the past. 13 refs., 4 figs.

5620 (CONF-9405258–, pp. 394-398) **Analysis of magnetotelluric data at Sengan-Sumikawa geothermal field.** Uchida, T. (Geological Survey of Japan, Tsukuba (Japan)); Mitsuhata, Y. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the result of analyzing the data acquired by an MT survey which was conducted by the NEDO and GSJ (Geological Survey of Japan) in Sengan-Sumikawa geothermal field. For that survey, laid were one north-south traverse line and two east-west traverse lines which were parallel and about 1km away from each other. The following is the result of two-dimensionally data-inverting, by a smoothing-controlled least square, both apparent resistivity and phase at 14 frequencies within a band of 0.01 to 100Hz: both east-west traverse lines roughly resemble each other in resistivity model. Down to the depth of 2km, the same structure is found as that of the two-dimensional model which is based on an EMAP (Electromagnetic Array Profiling) survey conducted before the present survey. The data acquired by resistivity logging near along the east-west traverse lines are harmonious in resistivity with what corresponds to them in the above two-dimensional model. The resistivity model along the north-south traverse line gives the same shallow low-resistivity layer as that obtained along the east-west traverse lines. 5 refs., 8 figs.

5621 (CONF-9405258–, pp. 399-404) **Application of 2 dimensional joint inversion of MT/ATM and Schlumberger data.**

Matsuo, K. (Nittetsu Mining Consultants Co. Ltd., Tokyo (Japan)); Kishimoto, M.; Sasaki, Y. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports an example of having applied a two-dimensional joint inversion by both AMT and Schlumberger. With a multi-purpose geophysical prospecting measurement unit V5-16 produced by Phoenix Geophysics, measurement by MT, AMT and Schlumberger was made at stations, at an interval of 100m, laid along a 1.2km long straight traverse line. The result of analysis was compared between the two-dimensional inversion solely by each of the three methods and that jointly by AMT and Schlumberger. When the ratio of AMT to Schlumberger was set at 1:1, 1:2 and 2:1 in weight due to the remainder between their respective measured data and calculated values, the following result was obtained: the present two-dimensional joint inversion heightens the resolving power of shallow low-resistivity structure. The resistivity structure at the target depth can be made clearer by more appropriately setting the above weight. 2 refs., 8 figs.

5622 (CONF-9405258–, pp. 469-473) **Development of vertical electromagnetic profiling (VEMP) method. Conceptual design and simulation results.** Miura, Y. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Kawakami, N.; Yasukawa, K. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

As a part of the 'Deep-seated geothermal resources survey' project undertaken by the NEDO, the vertical electromagnetic profiling (VEMP) method is being developed. This paper reported the simulation results on it. The VEMP is a way of getting the underground specific resistance structure based on the change in response of receiver installed in the well by changing the frequency of the source on the ground and by moving its position. It revealed that the underground resistivity distribution around the survey well which was being drilled in the geothermal area Kuzuneda, Iwate Prefecture was two-layers structure. Based on the assumption of specific resistance model in which the rectangular parallelopipedon (deep layer reservoir) is arranged to it, the sensitivity of VEMP method to the change in position of this rectangular parallelopipedon was investigated by numerical calculation. The results showed the following: The sensitivity of the phase data to the specific resistance structure was high. So that the presence of rectangular parallelopipedon was detected even it was apart from the well. The second field caused by the rectangular parallelopipedon got as large as a few percent of the first field. 3 refs., 8 figs., 1 tab.

5623 (ETDE/JP-mf–95723113) **Verification of geothermal exploration technology for fiscal 1993. Development of fractural type reservoir exploration /development of exploration by utilizing the micro-earthquake.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 301p. (In Japanese). Order Number DE95723113. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The present report explained the micro-earthquake data processing and analysis system to be utilized for the geothermal exploration. Together with synthesizing the total system and heightening its operability, development was made of functions to heighten and grasp the hypocentral accuracy, and totally six other ones to display and analyze the spatial distribution of hypocenters and other applied seismic distributions. The above functions presently developed are function to relatively calculate the hypocenters, function to evaluate the detecting ability of observation network, function to simulate the evaluation of hypocentral accuracy, function to support the hypocentral calculation with the foregoing functions to which other ones are added to analyze the velocity structural inversion, and functions to display and analyze the time series distribution, plane/sectional distribution, contour diagram and other applied seismic distributions with the foregoing functions to which other ones are added to display and analyze the b-value. Test was run with data observed in Kakkonda geothermal zone. Endowed with practicality, generality and geothermal speciality, a micro-earthquake data processing and analysis system could be structured as a result. 110 refs., 150 figs., 9 tabs.

5624 (ETDE/JP-mf–95730256) **Fiscal 1991 verification survey on geothermal exploration technology. Development of a method to explore fracture type reservoirs (development of an exploration method using elastic wave /development of downhole equipment for geothermal exploration).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Jan 1992. 349p. (In Japanese). Order Number DE95730256. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

The paper reports the results of the works done in fiscal 1991 for verification survey on geothermal exploration technology, development of a method to explore fracture type reservoirs, and development of an exploration method using elastic wave. As for manufacturing multilevel/digital type downhole receiving system, conducted were element tests on high temperature parts of downhole units and ground units, making basic specifications, system fabrication/temperature tests. Also, for the purpose of testing vibration followability and heat resistance of this system, VSP measurements were made in the field adopted to Yutsubo to study basic characteristics. For the tomography test to be conducted in fiscal 1992, a study of downhole energy source is made using the well in the Yutsubo field. In the experiment, elastic wave traveling between the holes is measured setting a detonator type energy source in No. 1 well and a downhole receiver in No. 2 well. As a result of the analysis, it is found that the detonator type energy source is one sufficient for the tomography survey in terms of both energy and frequency. 138 figs., 18 tabs.

1508 Geothermal Power Plants

Refer also to citation(s) 5514

1509 Geothermal Engineering

Refer also to citation(s) 5594, 5595, 5596, 5597, 5602, 5609

5625 (CONF-9405258–, pp. 7-11) **Evaluation method of subsurface crack behavior by triaxial AE doublets analysis and focal mechanism analysis.** Moriya, H. (Tohoku University, Sendai (Japan). Faculty of Engineering); Niitsuma, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Explanation was made of a triaxial AE doublets analysis which aimed at grasping the location and behavior of subsurface crack during the artificial subsurface crack creation. The explanation also contained the result of applying it to values experimentally measured in Yunomori Field and Okachi Hot Dry Rock Power Generation Field. The AE doublets are AE pairs (groups) which differ in time of creation but mutually have high relativity. Therefore, they are judged to be emitted, with equality in vibrating mechanism and undulatory propagation path, from on the same cracking plane underground. In the analysis, those AE pairs (groups) are extracted. Then, their absolute location is oriented by triaxial hodography. Finally, the relative location of the other AE sources is detected. The present analysis was applied to the data obtained in Yunomori and Ogachi Fields. As a result in Yunomori Field, the crack structural

plane due to hydraulic fracturing depended upon the preexisting crack formed by intrusive andesite. In Ogachi Field, plural crack structural planes were presumed to be equivalently of only one cracking plane, which structure agreed with the subsurface structure presumed from the regional lineaments. 8 refs., 5 figs.

5626 (CONF-9405258–, pp. 12-16) **Characterization of a subsurface fracture reopening by crosshole triaxial seismic measurement and sonic log.** Saito, H. (Kyushu University, Fukuoka (Japan). Faculty of Engineering); Niitsuma, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

To presume the reopening behavior of artificial subsurface fracture and contacting state of fractural plane in East Hachimantai Experiment Field of Tohoku University, undulatory propagation characteristics of seismic wave were investigated, crosshole seismic wave was triaxially measured, and acoustic velocity was logged by pressurizing the artificial subsurface fracture and changing the reopening state. In the triaxial crosshole measurement of seismic wave, delay in arrival of P-wave and attenuation of amplitude were observed. However in the acoustic velocity logging, the direct P-wave did not clearly change in undulatory propagation characteristics. When the seismic wave permeated the fractural plane partially having contact, it was made clear that, though difficult in the frequency range for the acoustic velocity logging, the application of LS model can be made in the frequency range for the triaxial crosshole measurement of seismic wave. Then, presumption was made of fractural plane contact rigidity and reopening behavior. As a result, the fracture was known to have parts which can not be expressed by LS model. In the parts expressible by LS model, the fractural plane contact rigidity and reopening behavior were known to conform in characterization to those obtained by fluid dynamics. 6 refs., 10 figs.

5627 (CONF-9405258–, pp. 31-35) **Analysis of fractures along a borehole axis at a geothermal well. Preliminary study for interpretation of 3D stress field using logging data.** Okabe, T. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Shinohara, N.; Takasugi, S.; Hayashi, K. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Logging and analysis by BHTV and FMI were made in order to detect and evaluate the fracture before and after the hydraulic crushing of geothermal well. As a result of BHTV logging, the number of fractures detected increased before and after its hydraulic crushing. Though artificially generated, new open cracks were not confirmed at approximate depths of mud water leakage. That leakage which was generated by the hydraulic crushing was judged attributable to the opening of originally existing natural cracks. The FMI logging which electrically surveys the borehole wall can easily give information about the stratification planes. Many fractures were detected due to stratification planes which traveled west-northwestward with a southwestward dip of 20° at the depth of 950 to 1100m. It was judged that some fractures leaking the mud water had largely depended upon the intrusive orientation of andesite and natural cracks during the hydraulic crushing, and lay on an intrusive boundary of andesite. The conclusion from the foregoing was that the evaluation of fracture, through logging by BHTV and FMI in advance, in the borehole is important for the hydraulic crushing. 3 refs., 7 figs.

5628 (CONF-9405258–, pp. 46-50) **Fracture detection method utilizing high magnetic permeability fluid tracer. Part 7. Development of three components magnetic sensor system for high temperature.** Osato, K. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Takasugi, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The newly developed three components magnetic sensor system for high temperature geothermal well was reported. There are two types in the system, i.e., (1) the BTBR system which detects the orientation and inclination of crack taking place near the well wall by transmitting vertical coil (frequency: 3 KHz) in the well and the receiving three-components magnetic sensor, and (2) the STBR system which detects the propagation of crack by the loop type transmitter (frequency: 11 Hz) installed on the ground surface and the receiving magnetic sensor in the well. The equipment to be installed in the well was designed so as to be able to operate for more than 4 hours under such severe conditions as 260°C and 200 kgf/cm^2. The characteristics of each part of the system were tested by a high temperature test on the ground. The practical measurement test on the geothermal well showed that the variance of measured data of the BTBR system was some 10^{-4} nT, while the noise level of the STBR was only 1 - 2 % of the measured value. The change in magnetic field could be detected by introducing the high magnetic permeability factor. 7 refs., 5 figs.

5629 (CONF-9405258–, pp. 304-308) **Study of gravity changes using numerical geothermal reservoir simulator.** Sato, T. (GERD Geothermal Energy Research and Development Co. Ltd., Tokyo (Japan)); Osato, K.; Takasugi, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper introduces an example of having studied, by numerical simulation, the change in surface gravity due to the geothermal reservoir behavior. Each of both shallow and deep reservoir models underwent both natural state simulation and geothermal fluid production/injection behavior predicting simulation. The change in gravity was calculated from the density differential of each of the model parts between the natural state and post-production/inject ion state. The profile of gravity change due to the behavior of shallow and deep reservoirs is shown to be of considerably short and long waves, respectively. The change in gravity due to the geothermal fluid production/injection which was made simultaneously in both shallow and deep reservoirs was tentatively calculated by making both their domains of density change not to be common and putting both their profiles of gravity change simply on top of each other due to the reservoir behavior. When processed by filtering, the profile of the thus calculated change in gravity shows it possible to investigate the influence of change in gravity with its sources grouped into both shallow and deep reservoirs. 6 refs., 8 figs.

5630 (LA-UR–94-2856) **Summary of recent flow testing of the Fenton Hill HDR reservoir.** Brown, D.W. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940120–6: 19. workshop on geothermal reservoir engineering, Stanford, CA (United States), 18-20 Jan 1994). Order Number DE94018304. Source: OSTI; NTIS; GPO Dep.

A sequence of reservoir flow tests has been conducted at the Fenton Hill Hot Dry Rock (HDR) test site as part of the Long-Term Flow Testing (LTFT) program. This testing, which extended over an aggregate period of about 8 months, has demonstrated several significant features concerning HDR reservoirs that taken together reflect very positively on the future development of the HDR concept into a viable commercial reality. Of most significance is the demonstrated self-regulating nature of the flow through such a reservoir. Both temperature and tracer data indicate that the flow, rather than concentrating in a few potential direct flow paths, progressively shifted towards more indirect flow paths as the test

proceeded. This self-regulating mechanism may be related to the strongly temperature-dependent viscosity of water. Measurements have shown that the reservoir flow impedance is concentrated in the near-wellbore region surrounding the production well. This situation may well be a blessing in disguise since this suggests that the distance between injection and production wells can be significantly increased, with a greatly enhanced access to fractured hot rock, without an undue impedance penalty. However, since the multiply interconnected joints within the HDR reservoir are held open by fluid pressure, a higher mean reservoir pressure is the obvious path to increased productivity while still retaining the distributed nature of the flow. Other significant observations include a very small rate of reservoir water loss that was still declining at the end of the flow testing, and a set of temperature measurements in the production well that show no significant temperature drawdown during the period of testing.

1520 Geothermal Data and Theory

Refer also to citation(s) 7017, 7018

17 WIND ENERGY

Refer also to citation(s) 6071

1704 Economic, Industrial, and Business Aspects

Refer also to citation(s) 5637, 5638, 5639, 5642

5631 (INIS-mf–15081, pp. 57-62) **Wind park of the Hannover-Braunschweigische Stromversorgungs-Aktiengesellschaft (HASTRA).** Hahnefeld; Fenske. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only); INIS.

In order to achieve the share of wind power in public electric power supply prognosticated for the year 2005 by the Enquete Commission it is necessary that favourable sites are utilized optimally with plants of medium size. The wind park of HASTRA serves as a reference plant. In the scope of this contribution the following subjects regarding this plant are mentioned: site and plant selection, licensing procedure, investments and profitability, energy economic aspects of wind power as well as operating experience and public acceptance. (BWI)

5632 (INIS-mf–15081, pp. 63-70) **The wind energy plant "Kronsberg" of Stadtwerke Hannover AG.** Heimhuber, B.; Bollbach, T. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only); INIS.

Within the scope of an investigation on the location in the area of Hanover, 18 plants have been investigated on 5 locations under technical-economic points of view. The test of the plants showed that only types in the capacity range above 100 kW could be taken into account due to the considerable additional exposures. The selected Enercon plant with 280 kW, which has been equipped with a higher tower and an enlarged rotor for inland operation, runs in normal operation parallel to the network since July 1989. This contribution deals with questions regarding cost, acceptance as well as operating experience. (BWI)

5633 (RISO-R–776(DA)) **Analysis operating and maintenance cost of Danish wind turbines in 1993.** Godtfredsen, F. Risoe National Lab., Roskilde (Denmark). Test Station for Wind Turbines. Oct 1994. 44p. (In Danish). Order Number DE95723835. Source: OSTI; NTIS; INIS; Also available from Risoe Library, P.O. Box 49, DK-4000 Roskilde, Denmark.

A study of operation and maintenance (O and M) cost of Danish wind turbines has been carried out. The study is based on a questionnaire survey by the wind turbine owners association. The study shows a significant decline in the O and M cost from 55 kW machines installed in 1980-87 to modern machines. In 1993, the average total O and M cost for 55 kW and 150 kW turbines was approximately 0.22 DKK/kWh and 0.07 DKK/kWh, respectively. For 150 kW turbines, insurance and administration costs amounted to 0.04 DKK/kWh while repair and maintenance costs came to 0.03 DKK/kWh. In 1993, repair and maintenance cost were significantly higher for older vintages of 55 kW and 150 kW turbines, but it is not possible based on this study to conclude whether increasing O and M costs generally comes with increasing age. The statistical basis of this study is not large enough to conclude whether there are positive scale effects for ST's from 105 kW. Similarly, because of relatively few large WT are older than 10 years, it is not possible based on this study to predict the size of major future repair costs/reinvestments. To estimate the O and M costs more exactly, a larger empirical basis is needed. (au) (8 tabs., 17 ills., 11 refs.)

1706 Wind Energy Engineering

Refer also to citation(s) 5517, 5562, 5632

5634 (EEV–94-01) **Gear boxes in wind turbines. Principles for calculation of fatigue under changing loads.** Fisker, J. Danske Elvaerkers Forenings Udredningsafdeling (DEFU), Lyngby (Denmark). Oct 1994. 245p. (In Danish). Order Number DE95723849. Source: OSTI; NTIS.

Cover title: Gearkasser i vindturbiner. Udmattelsesberegning.

This publication deals with calculations of gear boxes in power producing wind turbines connected to the power distribution network.The emphasis is on fatigue calculation for gears and roller bearings according to Palmgren/Miner's hypothesis. Reference spectra with regard to rotor axis are elucidated. A reference spectrum shows the torque ordered according to its numerical value, with velocity expressed in number of rotations during service life of the construction. Concepts of gear transmissions and calculations of their strength according to DIN 3900 and the Norwegian Veritas are described. For toothed gears it is shown how to determine strain-load spectra on basis of a reference spectrum, and how safety factors S_H for pitting and S_F for tooth fracture should be determined from comparing the stress-load spectra to the stress-fatigue curves.Different calculation methods are discussed, including a derived method for K_A factor determination. For roller bearings the stress-rotational spectra are presented and service life is estimated from these spectra and bearing fatigue value. (EG) (20 refs.)

5635 (ETDE/DE-mf–95726987) **Blade angle adjustment on wind turbines with individual flapping hinges. Final report.** Schubert, M.; Wienhold, M. Technische Univ. Berlin (Germany). Fachbereich 12 - Verkehrswesen. 1991. 187p. (In German). Order Number DE95726987. Source: OSTI; NTIS (US Sales Only).

In the context of the introduced research project, an aerodynamic brake for switching off in storms and in an emergeny of multiwing windpower plants with individual flapping hinges was developed by rotating the rotor blade around their longitudinal axis. As the pitch brake can only be used for windpower plants up to a maximum of 100-150 kW, an examination was made whether the combination of the flapping hinge rotor with pitch adjustment could be used for controlled output limitation. The hub was found to be stable in its dynamic behaviour in all tried manoeuvres. In parallel with the experimental investigations, the dynamic behaviour was analysed numerically. (BWI)

5636 (ETDE/DE-mf–95733315) **Wind power plants in North-Rhine Westphalia: Wind power generation in the dyked land of Northwestern Germany. Report on results.** Bartelt, H. Ministerium fuer Wirtschaft, Mittelstand und Technologie des Landes Nordrhein-Westfalen, Duesseldorf (Germany); WISTRA Windstromanlagen Beratungs- und Handelsgesellschaft mbH, Ibbenbueren (Germany). 1993. 124p. (In German). Project Number 322-8706031. Order Number DE95733315. Source: OSTI; NTIS (US Sales Only).

The report describes the experience gained by the WISTRA Windstromanlagen Limited Company as project sponsor carried out in co-operation with the University of Muenster and the University of Dortmund. The project consisted in the construction and operation of nine wind power plants at different locations in North

Rhine-Westphalia. The report includes data on the specific plants, cost surveys and general suitability considerations in terms of the wind climatology of potential locations for wind power plants. It also contains data concerning other suppliers of wind power plants. (orig./HW)

5637 (INIS-mf–15081) **Utilization of wind energy in greater Hanover.** Beitraege zur regionalen Entwicklung, v. 33. Sahling, U. (comp.). Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). Order Number DE95726698. Source: OSTI; NTIS (US Sales Only); INIS.

Since the beginning of the Eighties, the association of communities of Greater Hanover has dealt intensively with energy and ecopolitical questions in the scope of regional planning. Renewable energy sources play a dominant role in this context. This brochure is the third contribution to the subject "Energy policy and environmental protection". Experts as well as possibly interested parties are addressed especially. For all 8 contributions contained, separate entries have been recorded in this database. (BWI)

5638 (INIS-mf–15081, pp. 7-10) **Utilization of wind energy in Greater Hannover - an introduction.** Sahling, U. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only); INIS.

Although the association of communities of Greater Hanover has dealt with energy and ecopolitical questions since the Eighties, the utilization of regenerative energy sources has remained a stepchild for a long time. According to an expertise, wind energy has gained the greatest importance for Greater Hanover, since the potential is very high and the operational results can be assessed as favorable. (BWI)

5639 (INIS-mf–15081, pp. 11-39) **The wind energy potential in Greater Hannover.** Schulze, L. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only); INIS.

Due to its location, Greater Hanover offers a big potential for wind energy utilization. Due to restrictions regarding natural space, settlement structure and regional planning, the utilization of wind energy on a large surface area, however, is not possible or only relatively possible. The investigation shows that with small-area systems and wind parks, only the development of site quality class 1 (of 7 possible classes) and a fraction of the site quality class for the production of 15-20% of electric power consumption is necessary. The second part of this report deals with the costs of development as well as with the profits which can be gained, considering especially small-area systems. (BWI)

5640 (INIS-mf–15081, pp. 41-50) **Wind conditions on selected sites of Greater Hannover.** Tetzlaff, G.; Koenig, S. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only).

The aim of an investigation on the wind energy potential in Greater Hanover consists of the fact to find the most suitable sites. The profitability is determined by the four factors: efficiency of wind power plant, cost of the wind power plant, wind energy potential, and energy costs on site. Especially site factors are important. In this contribution, the influence of hills on the air flow on the one hand, and the influence of obstacles on the other hand, are investigated. Surface roughness in the neighbourhood as well as impediments in the immediate vicinity result in a decrease of the wind speed. The hill effect, however, results in an increase, provided that the site is on the right place of the hill. (BWI)

5641 (INIS-mf–15081, pp. 71-79) **"Wind power station Dillenberg" near Sulingen. Three years of wind power without environmental impact.** Wagner, H. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only).

The first wind power station at Dillenberg was commissioned in June 1989. In the meantime there are 5 wind power plants in the country of Sulingen, feeding the public network of HASTRA. In this way, 1.2% of the annual electric power consumed by the city of Sulingen are generated by the wind power plant. The results of the last few years show that the capacity of 430000 kWh/a assured by contract can be achieved in no way. It turns out that a reliable capacity prediction is an indispensable prerequisite. Further problems occurred with the financial support by the state as well as repeated error messages and defects of the control system. (BWI)

5642 (INIS-mf–15081, pp. 75-78) **Is the utilization of wind power interesting for farmers?.** Brueggemann, C. Kommunalverband Grossraum Hannover (Germany). Feb 1993. 83p. (In German). In *Utilization of wind energy in greater Hanover.* Order Number DE95726698. Source: OSTI; NTIS (US Sales Only); INIS.

The knowledge of the wind conditions on the location envisaged is an important prerequisite for a realistic estimation regarding the profitability of the wind power plant. This also includes an on-site analysis of the site, since obstacles in the main wind direction such as trees, houses, dikes, hedgerows etc. result in capacity reducing turbulences. Investigations show wind power plants in the capacity range between 150 and 350 kW have the most favourable cost of electric power generation. The payback period is calculated to by 10 years at the most. In view of the fact that profitability is often impossible to achieve, in spite of increased returns for power supply to the grid and favourable site conditions, public funding should be considered. (BWI)

5643 (NEI-DK–1720) **Modelling and control of a wind turbine.** Eksamensprojekt - IMSOR, 25. Ma Xin. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1993. 180p. Order Number DE95723827. Source: OSTI; NTIS.

The purpose was to investigate the role and effect of control systems for a wind turbine. The pitch angle control with a constant rotor speed is described. The wind turbine system with multiple control inputs is studied. The control strategy is optimized with respect to producing a constant amount of electrical energy and reducing undesired oscillations in the systems, and high fatigue load. The wind turbine system investigated has a three-bladed rotor which is connected to an asynchronous generator by a transmission. The wind power plant is connected to a large utility grid. Attention is given to the modelling of the system. Several subsystems of the wind turbine such as wind characteristics, rotor, drive train and generator, actuator are individually modelled. The aerodynamics are described as follows: the variation of wind speed is a stochastic process, which will be modelled by a mean speed superimposed by a turbulent wind speed. The model of transmission contains a drive train. The rotor is connected to the generator by a gear box in the drive train. Eventually both the general model structure and state-space model are employed for the different controllers design. Based on the system's model the controller design problem is handled by general stochastic pole placement design method and Linear Quadratic Gaussian method. Gain scheduling is also applied for the different operating conditions of the process. The multivariable Linear Quadratic Gaussian method controller is discussed. Dynamics of the closed-loop wind turbine were simulated. (AB) (17 refs.)

5644 (NEI-DK–1731) **Adaptive pitch control of wind turbine.** Eksamensprojekt - IMSOR, 27. Kjaer Joergensen, H. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1993. 248p. Order Number DE95723828. Source: OSTI; NTIS.

The wind turbines used in Denmark today to produce electric power are mostly stall-controlled turbines up to 300-400 kW. The quality of the produced electrical power from small stall-controlled wind turbines is poor compared to the electrical power from the utility grid. The main goal of this report is to describe another way of generating electric power by wind turbines. The produced power is regulated by controlling the pitch of the rotor blades. Only medium wind speeds ranging from 14 m^3 to 20 m^3 are considered. The regulation problem is to keep the power at the nominal value and to minimize variations in the produced power and variations in the torques acting upon the turbine. Furthermore fluctuations in the displacement of the nacelle have to be controlled so the natural frequency of the nacelle is not excited. The regulation problem is solved for the 750 kW wind turbine, Windane 40, owned by

ELKRAFT. A control model is developed for use in the control design procedure and a simulation model is developed to test the designed controllers. Several controllers are designed. A continuous-time PID-controller (Proportional Integrating Differentiating) is designed because this controller is used in practical pitch-control today - this controller is used as a reference of performance. A LQG-controller (Least Quadratic Gaussian) and a GSP-controller (General Stochastic Poleplacement) are designed to test some conventional controllers used to solve many other regulation problems. Finally an AGSP-controller (Adaptive General Stochastic Poleplacement) is designed to test a controller that is able to change the control law according to the wind speed. The controllers are tested at different wind conditions. All controllers are compared to a wind turbine with fixed pitch angle (stall-control). Simulation studies show that all controllers give better results than the fixed pitch-controlled system. (EG) (14 refs.)

5645 (NEI-DK–1758) **Development of a 19 m wing with improved capacity and structure. Final report.** Grabau, P. LM Glasfiber A/S, Lunderskov (Denmark). Nov 1994. 9p. (In Danish). Contract ENS-51171-92.0022. Order Number DE95723861. Source: OSTI; NTIS.

A short description of a project aimed at developing an innovative stall-regulated 19 m wind turbine blade for a 500 kW wind turbine. Tests showed that the blade produced more noise than expected and an increase in capacity which was less than expected. Other blades of a different form at the 10 m tip were produced. These were less noisy and resulted in a better increase in capacity. The document presents data on these turbine blades in detail, dealing with dimension, connections, the aerodynamic brakes, materials used, operational limits, mounting and capacity. The Test Station for Wind Turbines at Risoe National Laboratory (Denmark) worked together with the manufacturer on the design and the testing. (AB)

5646 (NREL/TP–442-7109) **NREL airfoil families for HAWTs.** Tangler, J.L. (National Renewable Energy Lab., Golden, CO (United States)); Somers, D.M. National Renewable Energy Lab., Golden, CO (United States). Jan 1995. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000267. Source: OSTI; NTIS; GPO Dep.

The development of special-purpose airfoils for horizontal-axis wind turbines (HAWTs) began in 1984 as a joint effort between the National Renewable Energy Laboratory (NREL), formerly the Solar Energy Research Institute (SERI), and Airfoils, Incorporated. Since that time seven airfoil families have been designed for various size rotors using the Eppler Airfoil Design and Analysis Code. A general performance requirement of the new airfoil families is that they exhibit a maximum lift coefficient ($c_{l,max}$) which is relatively insensitive to roughness effects. The airfoil families address the needs of stall-regulated, variable-pitch, and variable-rpm wind turbines. For stall-regulated rotors, better peak-power control is achieved through the design of tip airfoils that restrain the maximum lift coefficient. Restrained maximum lift coefficient allows the use of more swept disc area for a given generator size. Also, for stall-regulated rotors, tip airfoils with high thickness are used to accommodate overspeed control devices. For variable-pitch and variable-rpm rotors, tip airfoils having a high maximum lift coefficient lend themselves to lightweight blades with low solidity. Tip airfoils having low thickness result in less drag for blades having full-span pitch control. Annual energy improvements from the NREL airfoil families are projected to be 23% to 35% for stall-regulated turbines, 8% to 20% for variable-pitch turbines, and 8% to 10% for variable-rpm turbines. The improvement for stall-regulated turbines has been verified in field tests.

5647 (NREL/TP–442-7228) **Data preparation requirements for modeling wind turbines with ADAMS®.** Buhl, M.L. Jr. National Renewable Energy Lab., Golden, CO (United States). Dec 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000266. Source: OSTI; NTIS; GPO Dep.

This contains guidelines for the kind of information that designers need to model a complete wind turbine with ADAMS. The information here is not at all exhaustive. It does, however, represent the collective knowledge of two years of experience gained by National Renewable Energy Laboratory (NREL) engineers while using ADAMS to model wind turbines. If designers save the following information as they design a new turbine, they will have an excellent start on an ADAMS model. The more accurate the input data, the better the results will be. Designers will have to make the tradeoff between the required effort to improve their input data and the benefits of a more accurate simulation. The authors break the turbine into each of its major subsystems and describe them in detail. They attach a table of parameters to the end of the document to make it easier for one to keep track of data requirements.

5648 (NUTEK-VIND–94-11) **Electromagnetic noise in asynchronous generators.** Nordqvist, P. (School of Electrical and Computer Engineering, Chalmers University of Technology, Gothenburg (Sweden)). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). Nov 1993. 43p. (In Swedish). Project NUTEK-506-258. (CTH-R–92-12). Order Number DE95723994. Source: OSTI; NTIS.

This report discusses the electromagnetic sound in asynchronous generators and the possibility to minimize the noise with rotor skewing. 94 refs

5649 (RISO-R–743(EN)) **Fatigue loads on a pitch regulated wind turbine operating in a coastal wind turbine array.** Thomsen, K.; Bindner, H.; Friis Pedersen, T. Risoe National Lab., Roskilde (Denmark). Meteorology and Wind Energy. Nov 1994. 34p. Order Number DE95723836. Source: OSTI; NTIS; Also available from Risoe Library, P.O. Box 49, DK-4000 Roskilde, Denmark.

The objective of this analysis is to improve the foundations for designing wind turbines in wind turbine arrays and wind farms. The analysis is carried out using load measurements on a Vestas/DWT Windane 34 turbine operating in the Kappel wind farm in the southern part of Denmark. This report describes the fatigue loadings on the wind turbine operating in a coastal wind farm. The wind farm consists of 24 wind turbines erected in a single row, under such conditions that it has given the opportunity for investigation of the loads on a turbine operating in a very low-turbulent site in different near-wake situations. The laods are analyzed by means of statistics and fatigue, with the latter one represented by Rainflow counting distributions and damage equivalent load analysis. The analysis shows important differences in fatigue load spectra in different wake situations. These changes could contribute significantly to the life time consumption of the wind turbine components. However, in some cases it is possible to have the opposite situation, depending on e.g. wind farm layout and background turbulence intensity. (au) (3 tabs., 31 ills., 7 refs.)

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Refer also to citation(s) 4900, 4904, 4906, 4914, 4915, 4934, 4935, 4936, 4937, 4939, 4965, 4968, 4969, 4977, 4981, 4982, 4983, 5523, 6073, 6130, 6197, 6208, 6210

5650 (CONF-930521–13) **Advanced staged combustion system for power generation.** Rehmat, A.; Goyal, A. Institute of Gas Technology, Chicago, IL (United States). [1993]. 10p. Sponsored by Institute of Gas Technology, Chicago, IL (United States);Illinois Clean Coal Inst., Carterville, IL (United States). From 12. international conference on fluidized-bed combustion; San Diego, CA (United States); 9-13 May 1993. Source: OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616.

To respond to the increasing market need for a new generation of plants with a substantial improvement in efficiency and a reduction in capital cost, the Institute of Gas Technology has developed an advanced staged, fluidized-bed combustion system concept. The staged fluidized-bed partial combustor produces the fuel gas at about 1500 F. The fuel gas, after particulate removal, is directed to a gas turbine followed by a steam cycle. Adequate sulfur capture and solids waste stabilization are attained by separating calcination, carbonization, and gasification/combustion steps in the staged fluidized beds. Intermediate gas cooling is avoided during the process to maximize the power production. The coal-to-electricity

conversion efficiency of the system approaches 49 percent, which exceeds the efficiencies of the other emerging technologies.

5651 (CONF-940780–Vol.2, pp. 339-346) **Coal-fired performance power generating system.** Seery, D.J. (and others); Sangiovanni, J.J.; Robson, F.L.; Holowczak, J.E.; Bak, M.; Heap, M.; Pershing, D.W.; Smith, P.J.; Eddings, E.; Boni, A.A. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-92PC91155. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The need for generating electric power with increased efficiency and decreased emissions is widely accepted. This is especially true for coal-burning power plants. In fact, according to the DOE's National Energy Strategy of 1992, the use of coal for power generation will increase steadily over the next 50 years, doubling by the year 2030, even for a minimum growth scenario. When this growing demand for coal is considered along with the fact that by the year 2000 44 percent of the coal-fired powerplants in the US will be 30 years old or more, the opportunity for new systems and designs becomes evident. For the short term (approximately 5 years) the low price of natural gas favors the use of gas turbine combined cycle plants as a reasonable alternative for filling growing demands for electric power. In the longer term the limitations on infrastructure and perhaps the increased cost of natural gas will necessitate a return to coal-fired designs. Several options are available in addition to the normal pulverized coal steam boilers. The use of pressurized fluidized bed combustion (PFBC) in a combined cycle and the integrated gasification combined cycle (IGCC) have received considerable attention in recent years. While these approaches appear to be attractive in some applications, they are limited by difficulties with hot gas cleanup and high capital costs.

5652 (CONF-940780–Vol.2, pp. 347-358) **Materials support for the development of High Temperature Advanced Furnaces (HITAF) - a comparison of selected mechanical properties for three SiC-based ceramics.** Breder, K. (Oak Ridge National Lab., TN (United States)); Tennery, V.J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC05-84OR21400. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The purpose of this project is to compare structural ceramic materials proposed for use in the air heater of a coal fired high temperature advanced furnace (HITAF) for power generation. The work will provide necessary initial strength and statistical material parameters for design of a prototype system. Two teams are currently funded by Pittsburgh Energy Technology Center (PETC) under the Combustion 2000 program to develop such a system. One team is led by the United Technologies Research Corporation, and consists of UTC Turbo Power and Marine Division, Bechtel, Oak Ridge National Laboratory (ORNL) and a Joint Venture of Physical Sciences Inc. (PSI) Technologies, Reaction Engineering International (REI) and University of North Dakota Energy & Environmental Research Center (UNDEERC); the other team is led by Foster Wheeler Development Corporation, and members are AiResearch Division of AlliedSignal Aerospace Systems & Equipment, Research Cottrell, TRW, General Electric and Bechtel.

5653 (CONF-940780–Vol.2, pp. 359-366) **Development of a high-performance coal-fired power generating system with a pyrolysis gas and char-fired high-temperature furnace.** Shenker, J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-91PC91154. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

A high-performance power system (HIPPS) is being developed. This system is a coal-fired combined-cycle plant that will have an efficiency of at least 47 percent based on the higher heating value of the fuel. Emissions of NO_x and SO_2 are each to be no more than 0.15 lb/10^6 Btu, and particulates must be less than 0.0075 lb/10^6 Btu. Initial versions of this system are allowed to have 35 percent of the heat input from natural gas, but the ultimate goal is to have 95 percent heat input from coal. Foster Wheeler Development Corporation is leading a team effort with AlliedSignal Aerospace, Bechtel, Research-Cottrell, Foster Wheeler Energy Corporation, and TRW. The heart of system is a high-temperature advanced furnace (HITAF), which is a combination air heater/boiler. The HITAF is used to indirectly heat the gas turbine air up to 1800°F. The air is heated in alloy tubes to 1400°F and then in ceramic tubes to 1800°F. This temperature is the current practical limit that can be achieved with indirect heating. The temperature is then further raised by firing natural gas in a topping combustor.

5654 (CONF-940780–Vol.2, pp. 367-376) **Combustion 2000 low-emission boiler systems project - the ABB Team's Phase I activities.** Regan, J.W.; Borio, R.W.; Hargrove, M.J.; Palkes, M.; Wesnor, J.D.; Kaminski, R.S. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-92PC92159. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The overall objective of the Project is the expedited commercialization of advanced coal-fired low-emission boiler systems. The specified primary objectives are emissions of NOx and SOx less than one-third NSPS, particulates less than one-half NSPS, and air toxics in compliance. Secondary objectives are improved ash disposability, reduced waste generation, and increased generating efficiency. All primary, and all or some secondary objectives must be met without increasing the cost of electricity from a current "NSPS" plant. Because emission requirements vary from site to site, ABB elected to have two NOx targets (the contract target of 0.2 lb/million Btu and approximately 0.05 lb/million Btu) and to favor SOx and particulate control technologies which can be designed for emission levels lower than the contract targets with minimum impact on costs. The final deliverables are a design data base that will allow future coal-fired power plants to meet the stated objectives and a preliminary design of a commercial generation unit. The deliverables for Phase I are a Project Work Plan covering all four phases, concept and component evaluation and selection, an R&D and Test Plan, a preliminary Commercial Generating Unit design, and a Phase I report.

5655 (CONF-940780–Vol.2, pp. 377-383) **Engineering development of an advanced coal-fired low-emission boiler system.** Beittel, R. (Riley Stoker Corp., Worcester, MA (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC22-92PC92158. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Riley Stoker Corporation is leading one of three teams in a program for the expedited development of a new generation of pulverized coal-fired boiler systems. The overall objective is to develop relatively near term technologies to produce Low-Emission coal-fired Boiler Systems (LEBS) ready for full scale commercial generating plants by the end of the decade. The specified goal of this team is to develop a LEBS incorporating an advanced slagging system capable of meeting all emission and performance goals. The Riley project team consists of the following organizations: Riley Stoker/Deutsche-Babcock, Reaction Engineering International, Research Cottrell, Sargent & Lundy Engineers, Tecogen, and Textron Defense Systems.

5656 (CONF-940780–Vol.2, pp. 397-404) **Research on fundamental aspects of inorganic particle deposition in coal-fired equipment.** Rosner, D.E. (Yale Univ., New Haven, CT (United

States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract FG22-90PC90099. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

We review here results of our recent research on the deposition dynamics of combustion-generated particles in coal-fired power production technologies. In this summary we outline and illustrate the results of our recently developed methods to predict total surface deposition rates and associated convective heat transfer reductions for cylindrical targets exposed to distribution of particles suspended in the mainstream. By combining the essential features of recently developed single particle sticking probability laws with our correlation of the inertial impaction of particles on a circular cylinder in high Reynolds number cross-flow, we develop formulae and "universal" graphs which provide the dependence of particle deposition rates, and associated reductions in convective heat transfer, on such system parameters as mainstream velocity, mean particle size and target diameter. The deposition rate prediction procedures illustrated are efficient enough to be incorporated into future, improved "fouling propensity indices" and can also be used to motivate, evaluate and implement "ruggedization" and/or fouling reduction strategies. Details on these theoretical studies, and their immediate antecedents, will be found in our archival references. A judicious blend of (numerical and physical) experiments, theory, and intuition will continue to be necessary to economically arrive at methods/results to improve the generality and accuracy of future particle-deposition-related design calculations for a wide variety of equipment/fuel types. We propose that our computational and correlation methods be extended to treat more complex situations of practical importance in power generation applications.

5657 (CONF-940780–Vol.2, pp. 405-412) **Recent progress in the use of synchrotron radiation for the analysis of coal combustion products.** Manowitz, B. (Brookhaven National Lab., Upton, NY (United States)); Kang, S.G.; Bool, L.; Helble, J.J.; Shah, N.; Huffman, G.P. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. DOE Contract AC02-76CH00016. Contract AS-227-APD. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The formation and build-up of slag deposits on heat transfer surfaces is one of the most serious problems in pulverized coal combustion. This phenomenon, traditionally called wall slagging, is known to cause undesirable effects on heat and mass transfer and in some instances induce corrosion. Many empirical formulations based on silica percentage and acid/base ratio have been developed in the past to describe the slag characteristics. Unfortunately, due to variation of several factors such as flame turbulence, residence time, temperature distribution, gas velocity variance, etc. within the boiler, these empirical formulations are of limited use in the prediction of the behavior of the slag. Of even more importance, these formulations do not take into account the interaction of the coal constituents within and immediately after the flame. What is believed to be a major mechanism for the production of slag is the formation of low melting eutectic compounds in the post combustion region, many of which will stick to the heat transfer surface. The composition of this slag may very well change during operation as layers of the slaggy material build up or break off. An understanding of the chemical composition of such slags under boiler operating conditions and as a function of the mineral composition of various coals is the ultimate goal of this program.

5658 (CONF-940780–Vol.2, pp. 421-428) **Deposit growth and property development in coal-fired furnaces.** Baxter, L.L. (Sandia National Labs., Livermore, CA (United States)); Hardesty, D.R. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. Contract 0709. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The objectives of this research project are (1) to provide a self-consistent database of simultaneously measured, time-resolved ash deposit properties in well-controlled and well-defined environments and (2) to provide analytical expressions that relate deposit composition and structure to deposit properties of immediate relevance to Combustion 2000 programs. This project is distinguished from other projects in the same research area by: (1) the development and deployment of in situ, diagnostics to monitor deposit properties, (2) the time resolution of such properties during deposit growth, (3) simultaneous measurement of structural and composition properties, (4) development of algorithms from a self-consistent database that includes the interdependence of properties, and (5) application of the results to technologically relevant environments such as those being planned under the Combustion 2000 program. The deposit properties of principal interest in this project include the heat transfer coefficient, porosity, emissivity, tenacity, strength, density, and viscosity.

5659 (DOE/MC/21023–3926) **The analysis and specification of large high-pressure, high-temperature valves for combustion turbine protection in second-generation PFB power plants: Topical report.** Foster Wheeler Development Corp., Livingston, NJ (United States). Aug 1994. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC21023. Order Number DE95000019. Source: OSTI; NTIS; GPO Dep.

The purpose of this study was to provide a specification for the high-pressure/high-temperature valves for turbine overspeed protection in a commercial-scale second-generation pressurized fluidized bed combustion (PFBC) power plant. In the event of a loss of external (generator) load, the gas turbine rapidly accelerates from its normal operating speed. Protection from excessive overspeed can be maintained by actuation of fuel isolation and air bypass valves. A design specification for these valves was developed by analyses of the turbine/compressor interaction during a loss of load and analyses of pressure and flow transients during operation of the overspeed protection valves. The basis for these analyses was the Phase 1 plant conceptual design prepared in 1987.

5660 (DOE/MC/23165–3885) **Advanced coal-fueled gas turbine systems.** Wenglarz, R.A. Allison Engine Co., Indianapolis, IN (United States). Aug 1994. 149p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-86MC23165. Order Number DE95000010. Source: OSTI; NTIS; GPO Dep.

Several technology advances since the early coal-fueled turbine programs that address technical issues of coal as a turbine fuel have been developed in the early 1980s: Coal-water suspensions as fuel form, improved methods for removing ash and contaminants from coal, staged combustion for reducing NO_x emissions from fuel-bound nitrogen, and greater understanding of deposition/erosion/corrosion and their control. Several Advanced Coal-Fueled Gas Turbine Systems programs were awarded to gas turbine manufacturers for for components development and proof of concept tests; one of these was Allison. Tests were conducted in a subscale coal combustion facility and a full-scale facility operating a coal combustor sized to the Allison Model 501-K industrial turbine. A rich-quench-lean (RQL), low nitrogen oxide combustor design incorporating hot gas cleanup was developed for coal fuels; this should also be applicable to biomass, etc. The combustor tests showed NO_x and CO emissions $\leq$ levels for turbines operating with natural gas. Water washing of vanes from the turbine removed the deposits. Systems and economic evaluations identified two possible applications for RQL turbines: Cogeneration plants based on Allison 501-K turbine (output 3.7 MW(e), 23,000 lbs/hr steam) and combined cycle power plants based on 50 MW or larger gas turbines. Coal-fueled cogeneration plant configurations were defined and evaluated for site specific factors. A coal-fueled turbine combined cycle plant design was identified which is simple, compact, and results in lower capital cost, with comparable efficiency and low emissions relative to other coal technologies (gasification, advanced PFBC).

5661 (DOE/MC/29309–95/C0408) **Integration of an advanced technology gas turbine in an air blown gasifier.** Burrow, J.D.; Motter, J.W.; Ashley, T.A.; Batistta, R.A. Sierra Pacific Power Co., Reno, NV (United States). [1994]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-92MC29309. (CONF-941210–1: Power generation conference, Orlando, FL (United States), 7-9 Dec 1994). Order Number DE95004233. Source: OSTI; NTIS; GPO Dep.

The Pinion Pine IGCC project is an 800 ton-per-day air-blown integrated gasification combined cycle (IGCC) plant at Sierra Pacific Power Company's Tracy Station near Reno, Nevada. The Pinion Pine project is the first air blown IGCC power plant to incorporate an "F"-technology gas turbine generator. This type of combustion turbine has a high combined cycle efficiency which greatly enhances the economic justification of an IGCC application. The Pinion Pine Power Project will be an early application of the MS6001FA which is nominally a 70 MW design, scaled from the MS7001FA. This paper reviews the basic overall gasification and power plant configuration of The Pinion Pine Power Project and focuses on the integration of the MS6001FA gas turbine within this configuration. Specifically, aspects of the low BTU combustion system, compressor air extraction, fuel delivery system and control system are addressed.

5662 (DOE/METC–94/1008-Vol.2, pp. 572-574) **Properties of ceramic candle filters.** Pontius, D.H. (Southern Research Institute, Birmingham, AL (United States)); Starrett, H.S. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-89MC26239. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of this program have been: (1) the post-test evaluation of candle filters, (2) to measure the material properties of current filter materials, destructively and non-destructively, and to relate these properties and behaviors to in-service performance, (3) to develop an understanding of the material requirements for hot gas filter elements, (4) to develop material property goals for filter materials, and (5) to establish test matrices and a protocol to evaluate candidate filter materials. This last objective is particularly critical to the government and to potential material suppliers. An effective protocol for evaluating candidate materials would increase the likelihood of success when a commitment was made by the government for large scale testing in one of the process development units such as Tidd or Karhula. It would also decrease the financial burden for material manufacturers because they would not scale-up fabrication and/or manufacturing on materials until they had reasonable chance for success in large scale evaluations. The program objectives were defined based on a materials characterization philosophy to (1) measure intrinsic material properties, (2) use test methods, test conditions, and test matrices that are sensitive to applications and the particular material being evaluated, (3) support system designers by providing predictive properties and properties for performance assessment, and (4) support materials manufacturers.

5663 (DOE/METC–94/1008-Vol.2, pp. 575-579) **Results of patch tests.** Pontius, D.H. (Southern Research Institute, Birmingham, AL (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-89MC26239. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of this work were to construct, install, and operate a patch testing unit on a hot gas stream at a coal-fired fluidized-bed boiler. A 2000-hour "patch test" was conducted on ceramic disks of materials used in the fabrication of ceramic candles and ceramic cross-flow filters. The primary issues addressed in these tests were the long-term physical, thermal, and chemical stability of the ceramic materials; long-term pressure drop and filtration characteristics of the ceramic filters; potential for irreversible blinding of filter elements; and long-term performance and reliability of auxiliary hardware, such as the tube sheet and pulse-cleaning systems.

5664 (DOE/METC–94/1008-Vol.2, pp. 580-588) **PFBC dust cake studies.** Newby, R.A. (Westinghouse Electric Corp., Pittsburgh, PA (United States)); Alvin, M.A.; Bachovchin, D.M.; Smeltzer, E.E. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-87MC24257. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The Westinghouse Electric Corporation, Science & Technology Center is developing an Integrated Low Emissions Cleanup (ILEC) concept for high-temperature gas cleaning to meet environmental standards, as well as to provide economical gas turbine life. The ILEC concept simultaneously controls particulate, sulfur, alkali, and other contaminants in high-pressure fuel gases, or combustion gases, at temperatures up to about 1700°F in advanced, coal-fired, power generation systems. The overall objective of this program is to demonstrate, at a bench scale, the conceptual, technical feasibility of the ILEC concept for multi-contaminant control, and to provide test data applicable to the design of subsequent field tests. The current program objective is to conduct ceramic barrier filter testing under simulated PFBC conditions to deal with filter cake permeability and pulse cleaning issues that have been identified in recent PFBC filter field testing.

5665 (DOE/METC–94/1008-Vol.2, pp. 690-699) **Co-firing waste materials in an advanced pressurized fluidized-bed combustor.** DeLallo, M.R. (Gilbert/Commonwealth, Inc., Reading, PA (United States)); McDaniel, H.M. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-89MC25177. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

A study has been undertaken to investigate the technical and economic feasibility of co-firing a pressurized fluidized-bed combustor (PFBC) with coal and municipal or industrial wastes. Focus was placed on the production of electricity and the efficient disposal of wastes for application in a central power station and distributed locations. Wastes considered for co-firing include municipal solid waste (MSW), municipal sewage sludge, and industrial de-inking sludge. Issues concerning waste material preparation and feed, PFBC operation, plant emissions, and regulations are addressed. This paper describes the results of the performance evaluation completed as part of this study, and provides recommendations for further evaluation.

5666 (DOE/PC/91155–T7) **Coal-fired high performance power generating system. Quarterly progress report, January 1, 1994–March 31, 1994.** United Technologies Corp., East Hartford, CT (United States). Research Center. [1995]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-92PC91155. Order Number DE95004316. Source: OSTI; NTIS; GPO Dep.

The goals of the program are to develop a coal-fired high performance power generation system (HIPPS) by the year 2000 that is capable of (1) > 47% thermal efficiency; (2) NO_x, SO_x and particulates <25% NSPS; (3) cost ≥65% of heat input; (4) all solid wastes benign. In order to achieve these goals, this team has outlined a research plan based on an optimized analysis of a 250 MW, combined cycle system applicable to both frame type and aeroderivative gas turbines. Under the constraints of the cycle analysis the authors have designed a high temperature advanced furnace (HITAF) which integrates several combustor and air heater designs with appropriate ash management procedures. Recent efforts in cycle optimization for focusing on various repowering designs as expanded opportunities for the HIPPS concept. After

reviewing the full range of options, this analysis examines (a) windbox repowering, (b) feedwater heating repowering, and (c) full repowering. The preliminary conclusion is that the latter offers the most economic incentive. Under Task 3.1.6, the authors are investigating different approaches to waste utilization for the authors' HIPPS commercial plant design. The economic and engineering aspects of utilizing the byproducts from FGD and coal combustion ash are being reviewed. The conditions for economic use of by product gypsum are addressed and outlined in this report. The corrosion of ceramic materials by high temperature coal ash is a continuing subject of the authors' efforts. They report here some corrosion tests of four different SiC samples by both Wyodak and Illinois No. 6 ash at 1093°C and 1260°C. The results to date indicate that corrosion remains a major unsolved problem for structural ceramic materials at the extreme conditions in this plant design.

5667 (DOE/PC/91162–T11) **Development & testing of industrial scale, coal fired combustion system, Phase 3. Tenth quarterly technical progress report, April 1, 1994–June 30, 1994.** Zauderer, B. Coal Tech Corp., Merion Station, PA (United States). 12 Jul 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-91PC91162. Order Number DE95004318. Source: OSTI; NTIS; GPO Dep.

The effort of the second quarter of calendar year 1994 was devoted to the task 5, "Site Demonstration" effort. The purpose of the task 5 effort is to operate the combustor over extended periods in order to fully simulate commercial operation under conditions that meet the combustion and environmental specifications for this project. To accomplish this, it is planned to extend the test duration beyond the scheduled 500 hours and recover part of the added costs by placing the steam production from the boiler to beneficial use. As in the previous quarter, the primary activity in this quarter was to locate a site the task 5 test effort. The site requirements were: Internal space in a separate building with 2500 sq.ft for the combustor boiler, external space of 2000 sq.ft for fuel storage and processing, blowers, and stack cleanup equipment, 250 kW power supply, and spring or river water for cooling and steam condensation. In addition, the site should have a requirement for at least 17,500 lb./hr of process or heating steam and/or up to 300 kW of electric power. The revenue from this energy sale would be used to extend the combustor operating time beyond that in the original project plan.

5668 (ETDE/DE-mf–95726792) **VEW-Harpen Kraftwerk Werne. Annual report 1993.** VEW-Harpen Kraftwerk Werne oHG, Werne (Germany). 1994. 24p. (In German). Order Number DE95726792. Source: OSTI; NTIS (US Sales Only).

The tasks and utilities of this German utility are described, including many financial data (balance sheet, profit-and-loss account etc.). The utility operates a 745 MW combined-cycle coal power plant at Werne-Sotkcum since Werne-Stockum. (UA)

5669 (ETDE/DE-mf–95726793) **STEAG und VEW, Gemeinschaftskraftwerk Bergkamen. Annual report 1993.** Steag und VEW, Gemeinschaftskraftwerk Bergkamen A oHG (Germany). 1994. 24p. (In German). Order Number DE95726793. Source: OSTI; NTIS (US Sales Only).

The tasks and activities of this Germany utility are described. The 1993 annual report contains many financial data (balance sheet, profit-and-loss account, etc.). The utility operates a 750 MW coal power plant at Bergkamen-Heil since 1981. (UA)

5670 (LUTMDN-TMVK–5242) **The marginal efficiency of combined cycle gas turbines.** Nilsson, Pontus. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Nov 1994. 77p. Order Number DE95723984. Source: OSTI; NTIS.

Examination paper.

The combined cycle power plant consists of a coal fired boiler with steam turbines, where the feedwater is preheated with the exhaust heat from the gas turbine. The idea behind this type of combined cycle power plant is to take the design from a normal coal fired steam power plant, redesign it by removing the steam extractions from the turbines and install a gas turbine with a heat recovery preheater for the feedwater preheating. Compared to the nominal steam power plant, with steam extraction feedwater preheating, the consequences are substantial for the steam cycle of the combined power plant. The coal fired boiler, steam turbines and the condenser receive an increased mass flow and these components have to be redesigned. The steam turbines deliver more power, which means that more electrical power is generated at the generator terminals. The study consists of a broad parametric study on the combined cycle power plant to find out the most suitable gas turbines for this purpose and performance. One important result is the marginal efficiency, which is defined to find out with what efficiency the gas is converted into electricity when the gas turbine is used in this type of combined cycle. The definition itself is also discussed. 5 refs. 60 figs

5671 (ORNL/FMP–94/1, pp. 3-9) **Fabrication of fiber-reinforced composites by chemical vapor infiltration.** Stinton, D.P. (Oak Ridge National Lab., TN (United States)); Schwarz, O.J.; McLaughlin, J.C. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Fiber-reinforced SiC-matrix composites of thick-walled tubular geometry have been fabricated by forced chemical vapor infiltration (CVI). Densification of fibrous preforms required very long times (greater than 150 hours) using the initial equipment configuration. After numerous modifications to the processing equipment that altered the temperature gradient, infiltration times were reduced to less than 40 hours. This paper will discuss the modifications to the processing equipment that successfully reduced the densification times.

5672 (ORNL/FMP–94/1, pp. 11-18) **Transport properties of ceramic composites.** Starr, T.L. (Georgia Institute of Technology, Atlanta, GA (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

We describe our recently initiated experimental investigation of the transport properties of chemical vapor infiltration (CVI) preforms and densified composites, with particular emphasis on gas permeability and mass diffusivity. The results of this work will be useful both for on-going CVI process development and for evaluation and optimization of composite materials for fossil energy applications. Permeability values derive from measurements of pressure drop across the composite specimen at a controlled gas flow rate. Previous measurements were limited to composites with a simple cloth-layup architecture. These provided data for CVI model validation and revealed the importance of the large-scale pore structure to gas flow. Ongoing measurements include additional fiber architectures, e.g. 3-D woven and filament wound composites. Mass diffusivity values derive from measurements of gas composition changes with zero pressure drop (no flow) across the specimen. A gas chromatography-type thermal conductivity detector is used. Existing thermal conductivity data are reviewed to compare with gas transport results and to identify additional measurement needs.

5673 (ORNL/FMP–94/1, pp. 19-28) **Investigation of properties and performance of ceramic composite components.** Reifsnider, K.L. (Virginia Polytechnic Institute and State Univ., Blacksburg, VA (United States)); Stinchcomb, W.W.; Oleksuk, L.; Lee, S.S. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The present paper summarizes some recent results of an effort to address the need for reliable and durable structural ceramic composites for high temperature fossil energy environments. The general objectives of the program are to develop and validate a test system and methodology for the mechanical characterization of ceramic composite tubes under multiaxial cyclic and quasi-static thermo-mechanical loading, to use that test system and methodology to test, evaluate, and characterize the properties and performance of ceramic composite tubes in coordination with Oak

Ridge National Laboratory (a developer of such tubes), and to develop predictive models for damage tolerance and reliability of ceramic composite components. The present paper reports just two elements of that effort, which bear on the long-term performance of ceramic composites at elevated temperature in ambient air.

5674 (ORNL/FMP–94/1, pp. 29-39) **Development of nondestructive evaluation methods and prediction of effects of flaws on the fracture behavior of structural ceramics.** Ellingson, W.A. (Argonne National Lab., IL (United States)); Singh, J.P.; Sivers, E.A.; Holloway, D.L.; Jacobs, T.D.; Dieckman, S.L.; Singh, D. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract W-31109-ENG-38. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Work in this project is directed toward correlation of data obtained from NDE methods with fracture behavior. In the NDE area, specimens with different cloth lay-up orientations were examined by 3-D X-ray microtomography and image processing to measure and map in-plane fiber orientations. Results show detection sensitivity to better than ±3°. We also completed initial 3-D FFT image analysis to establish detection of 3-D braid/weave fiber orientation and spacing. Another NDE method, multinuclear (^{13}C, ^{29}Si, and ^{11}B) NMR spectroscopy, is being developed to determine the chemical state of the fiber surface and its potential impact on fiber pullout. We have conducted initial studies to investigate sensitivity to bulk composition of the matrix materials (a,b amorphous phase, silica, and oxynitride concentration). The first ^{29}Si NMR experiments focused on methods to enhance the signal from the surface by selectively reducing surface relaxation. Additionally, we have determined that there is sufficient sensitivity of ^{11}B NMR for monitoring fiber coatings. In the fracture behavior area, microstructural and mechanical properties of Nicalon-fiber-reinforced SiC-matrix 2-D laminated composites were studied in specimens with fiber cloth lay-up sequences of 0°/45° and 0°/20°/60°. These were evaluated to (a) estimate the effects of fiber cloth lay-up orientation sequence on mechanical properties and (b) characterize the effects of high-temperature exposure on flaw morphology and fracture behavior. The average first matrix cracking stress and ultimate strength are given. Evaluation of effects of a high-temperature environment on fracture behavior are discussed. This strength degradation at high temperature is believed to be related to fiber degradation.

5675 (ORNL/FMP–94/1, pp. 41-50) **Engineering-scale development of the vapor-liquid-solid (VLS) process for the production of silicon carbide fibrils.** Hollar, W.E. Jr. (Carborundum Co., Niagara Falls, NY (United States)); DeAngelis, T.P.; Hua, C.T.; Ko, F.K.; Scardino, F. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

As composite reinforcements, VLS SiC fibrils have attractive mechanical properties including high strength, high modulus, and excellent creep resistance. To make use of their excellent mechanical properties in a composite, a significant volume fraction (> 10%) of aligned, long fibrils (> 5 mm) needs to be consolidated in the ceramic matrix. The fibrils must be processed into an assembly that will allow for composite fabrication while maintaining fibril alignment and length. We are investigating several approaches to achieve this goal, including spun yarn, wet casting, and tape forming. A modified yarn spinning process has been tested. This concept consisted of fibril disentangling and alignment followed by a yarn forming step. The primary difficulty with this approach occurred during disentangling, where fibril fracture occurred. Two alternative processes are under development to avoid this problem. These are slurry and tape-assisted forming of aligned fibrils. These techniques have been demonstrated using fibrils as well as model ceramic fibers. The future direction for process development will be discussed.

5676 (ORNL/FMP–94/1, pp. 79-88) **Testing of full size fiber reinforced hot-gas filters fabricated by chemical vapor deposition.** Smith, R.G. (3M Co., St. Paul, MN (United States)); Eaton, J.H.; Weaver, B.L.; Kahnke, J.L. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The goal of the work described here has been to develop a hot gas candle filter which is light weight, has a thin wall, resists mechanical and thermal shock, and is resistive to alkali attack. A ceramic fiber reinforced, ceramic matrix composite approach has been followed to fabricate this new candle filter. Filter testing results and mechanical property testing results on as fabricated and tested filters will be presented. Based on the first test results of two ceramic composite candle filters at the Westinghouse Science and Technology Center in March of 1993 improvements were made in the filter's construction and fabrication processing. Twelve improved full size, 60 mm diameter by 1575 mm length, filters were fabricated. In this extension to the contract six of the ceramic composite candle filters were tested at the Westinghouse Science and Technology Center in December of 1993. All six filters met or exceeded performance requirements set for them. The filters were tested for 172 hours at 820 C and a 689 kPa operating pressure in a simulated PFBC environment using natural gas heating and the Old and Red Grimethorpe ashes. In addition, 14 thermal shock tests were completed over a twelve hour period. Thirty four samples were taken on the clean side of the test vessel with an average ash concentration of 2.6 ppm versus the 2000 ppm ash feed rate. All samples were below the 10 ppm upper limit requirement. A uniform base pressure of 7.5 kPa was established at 3.5 cm/sec face velocity and the filters cleaned with 2070 kPa air pulses into the chamber after the filter pressure increased to 7.5 kPa above the base pressure.

5677 (ORNL/FMP–94/1, pp. 185-194) **In-situ fireside corrosion testing.** Blough, J.L. (Foster Wheeler Development Corp., Livingston, NJ (United States)); Krawchuk, M.T.; Van Weele, S.F. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

A variety of developmental and commercial tubing alloys and claddings has previously been exposed to laboratory fireside corrosion testing simulating a superheater or reheater in a coal-fired boiler. This program will expose 347, RA-85H, HR-3C, 253MA, Fe_3Al + 5Cr, 310 modified, NF-709, 690 clad, and 671 clad samples to the actual operating conditions of a 250-mW coal-fired boiler. The samples will be installed on an air-cooled, retractable corrosion probe, installed in the reheater cavity, controlled to the operating metal temperatures of an existing and advanced-cycle coal-fired boiler and exposed for 4000, 12,000, and 16,000 hours of operation. After the various exposures, the samples will be metallurgically examined to determine the wastage rates and mode of attack. The final design of the 2-temperature zone probe has been completed, and the samples are being prepared for fabrication of the probe.

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Refer also to citation(s) 4884, 4918, 4919, 4920, 4921, 4922, 4923, 4924, 4925, 4926, 4927, 4928, 4929, 4930, 4938, 4940, 4941, 4943, 4945, 4946, 4947, 4948, 4949, 4950, 4951, 4952, 4953, 4954, 4955, 4964, 4975, 4976, 4978, 4984, 4995, 5654, 5655, 5666

5678 (CONF-940780–Vol.2, pp. 541) **Evaluation and further development of various sampling and analytical methods for determining specific toxic emissions from coal-fired power plants.** Khosah, R.P. (Advanced Technology Systems, Inc., Monroeville, PA (United States)); Clements, J.; Agbede, R.O. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and*

environmental control contractors conference: Proceedings. Volume 2. 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

A literature search of the state-of-the-art sampling and analytical methodology for size-fractionated particulate and vapor phase samples from stack effluents was performed. The identified methodology was compared with that employed by the five contractors that the Department of Energy (DOE) selected to conduct a series of air toxic emission tests at nine test sites. In addition, a critique of the emission studies reports generated by the five contractors were performed based on several test/target criteria. These criteria included data quality and integrity, adherence to QA/QC protocol, satisfaction of DOE objectives from the findings, and the identification of opportunities for method improvements.

5679 (CONF-940780–Vol.2, pp. 547-554) **Plasma-assisted NH_3 injection for NO_x control.** Chess, K. (Carnegie Mellon Univ., Pittsburgh, PA (United States)); Yao, S.C.; Russell, A. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The control of NO_x emissions from many utility boilers is required under the acid rain provisions of the 1990 Clean Air Act Amendments. While these provisions specify reduced emission factors achievable with combustion modifications, additional emission reductions may be necessary to comply with Title I of the Act to control ground-level ozone in some areas. Such additional requirements would potentially be met with post-combustion, flue gas treatment controls like selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR).

5680 (CONF-940780–Vol.2, pp. 621-628) **Development of a rotary combustor for refiring pulverized coal boilers.** Virr, M.J. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

The company has investigated the feasibility of using the ROTARY COMBUSTOR (RC) as a replacement for the conventional pulverized coal burners on utility and industrial boilers while burning coal to low emissions. The effort is focused on the design, manufacture and testing of a prototype burner to be tested and demonstrated at Detroit Stoker Company's test facility.

5681 (DOE/METC–94/1008-Vol.2, pp. 591) **Comprehensive assessment of toxic emissions from coal-fired power plants.** Brown, T.D. (Pittsburgh Energy Technology Center, PA (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The Department of Energy through the Air Toxics Control Program at the Pittsburgh Energy Technology Center (PETC) has been conducting comprehensive assessments of toxic emissions from coal-fired power plants since 1990. The power plants assessed represent an excellent cross section of the combustion and pollution control technologies in current use, with power plants demonstrating advanced control technologies being funded under PETC's Office of Clean Coal Technology. Data from the assessments will be used in the mandated risk assessment being performed by the Environmental Protection Agency. A presentation on the Air Toxics Control Program and results from the assessments will be made at the upcoming Advances in IGCC and PFBC Review Meeting.

5682 (DOE/METC–94/1008-Vol.2, pp. 592-606) **Trace element emissions.** Erickson, T.A. (Univ. of North Dakota, Grand Forks, ND (United States)); Steadman, E.N.; Zygarlicke, C.J.; Hauserman, W.B.; Hassett, D.J. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-92MC28016. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The Energy & Environmental Research Center (EERC) is carrying out an investigation that will provide methods to predict the fate of selected trace elements in integrated gasification combined cycle (IGCC) and integrated gasification fuel cell (IGFC) systems to aid in the development of methods to control the emission of trace elements determined to be air toxics. The goal of this project is to identify the effects of critical chemical and physical transformations associated with trace element behavior in IGCC and IGFC systems. The trace elements included in this project are arsenic, chromium, cadmium, mercury, nickel, selenium, and lead. The research seeks to identify and fill, experimentally and/or theoretically, data gaps that currently exist on the fate and composition of trace elements. The specific objectives are to (1) review the existing literature to identify the type and quantity of trace elements from coal gasification systems, (2) perform laboratory-scale experimentation and computer modeling to enable prediction of trace element emissions, and (3) identify methods to control trace element emissions.

5683 (DOE/METC–94/1008-Vol.2, pp. 607-615) **HAP sampling at Tidd PFBC.** Dal Porto, P.A. (Ohio Power Co., Columbus, OH (United States)). Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FC21-89MC26042. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objective of this project was to sample process streams of the Tidd PFBC plant and to characterize the HAPs associated with those various process streams. The data are comparable to HAP data collected by DOE and EPRI studies at conventional coal-fired utility plants.

5684 (DOE/METC–94/1008-Vol.2, pp. 616-626) **Trace species emissions for IGFC.** Pigeaud, A. (Energy Research Corp., Danbury, CT (United States)); Helble, J.J. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract AC21-92MC29261. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The objectives of this investigation are to study both the fate and distribution of at least five significant, coal-derived "trace" elements commonly present in coal-gas, in terms of their vaporization during gasification, their condensation and sorption during hot-gas cleanup, as well as their effects on fuel cells, gas turbines, and ultimately the environment. The definition here of "trace" does not include the major contaminants of sulfur and chlorine, etc., although the simultaneous presence of such major species is always considered in our thermochemical calculations. Of course, many other elements can vaporize in trace quantities from raw coal as either volatile, molecular compounds or as metallic vapors which, besides their deleterious action on the energy conversion systems, can also be detrimental to plant and animal life when emitted into the atmosphere. Hence, an understanding is sought of how the type and quantity of significant trace species in coal-gas changes from the coal pile through cleanup subsystems and the electric generators to the exhaust stack of an integrated system.

5685 (DOE/METC–94/1008-Vol.2, pp. 627-631) **Hazardous air pollutant sampling for advanced power systems.** Wetherold, R.G. (Radian Corp., Austin, TX (United States)); Williams, A.; Maxwell, D.P.; Mann, R.M.; Burrows, D.B. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology

Center. Jun 1994. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

This program will characterize an advanced power system to fulfill the following objectives: To quantify HAP emissions; To determine HAP distribution; To define internal control device effectiveness; and To characterize the hot, raw syngas. Two additional project objectives are (1) to compile data in a relational database system to enhance its review and analysis and (2) to determine emission factors for the turbine and incinerator exhaust streams. The project will use innovative sampling techniques, very sensitive analytical techniques, and an enhanced quality assurance/quality control program.

5686 (DOE/METC–94/1008-Vol.2, pp. 632-633) **Instrumentation for trace emission measurements.** Chisholm, W.P. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

Rising concerns about the potential release of harmful elements into the environment from coal utilization have driven the development of new analytical capabilities. And recent environmental regulations, such as the Clean Air Act and Amendments, demand superior performance from new coal-based technologies as regards their pollution emission potential. In particular, a number of toxic or hazardous trace elements found in coal must be measured and controlled.

5687 (DOE/METC–94/1008-Vol.2, pp. 679-689) **Market assessment and technical feasibility study of PFBC ash use.** Bland, A.E. (Western Research Institute, Laramie, WY (United States)); Brown, T.H.; Georgiou, D.N.; Wheeldon, J. Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center. Jun 1994. DOE Contract FC21-93MC30127. (CONF-9406131–Vol.2: Coal-fired power systems: advances in IGCC and PFBC review meeting, Morgantown, WV (United States), 21-23 Jun 1994). In *Proceedings of the coal-fired power systems 94: Advances in IGCC and PFBC review meeting. Volume 2.* 262p. Order Number DE94012253. Source: OSTI; NTIS; GPO Dep.

The overall objectives of this study are to determine the market potential and the technical feasibility of using PFBC ash in high volume ash use applications. The information will be of direct use to the utility industry in assessing the economics of PFBC power generation in light of ash disposal avoidance through ash marketing. In addition the research is expected to result in the generation of generic data on the use of PFBC ash that could lead to novel processing options and procedures. The specific objectives of the proposed research and demonstration effort are: define present and future market potential of PFBC ash for a range of applications (Phase I); assess the technical feasibility of PFBC ash use in construction, civil engineering and agricultural applications (Phase II); and demonstrate the most promising of the market and ash use options in full-scale field demonstrations (Phase III).

5688 (DOE/PC/89651–T15) **Innovative Clean Coal Technology (ICCT): 500 MW demonstration of advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. Phase 3A, Low NO_x burner tests.** Woodward Clyde Consultants, Santa Ana, CA (United States); Southern Co. Services, Inc., Birmingham, AL (United States). 15 Mar 1993. 89p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-90PC89651. Contract C-91-000027. Order Number DE95002388. Source: OSTI; NTIS; GPO Dep.

This Phase 3A test report summarizes the testing activities and results for the third testing phase of an Innovative Clean Coal Technology (ICCT) demonstration of advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. The project is being conducted at Georgia Power Company's Plant Hammond Unit 4 located near Rome, Georgia. The primary goal of this project is the characterization of the low NO_x combustion equipment through the collection and analysis of long-term emissions data. Described in this report are the test plans, data measurements, and data analyses performed during the Phase 3A effort. The present report also contains sufficient background material to provide an understanding of the overall program scope, the relationship of Phase 3A to the overall program, the testing methodologies, testing procedures, and unit configuration. Results from 66 short-term tests indicate increasing NO_x emissions over the load range ranging from 0.5 lb/MBtu at 300 NM to around 0.65 lb/MBtu at 480 MW. Fly ash loss-on-ignition (LOI) for these loads ranged from 5.4 to 8.6 percent. Long-term test results indicated high load (480 MW) NO_x emissions of approximately 0.65 lb/MBtu. At the 300 MW mid load point, the emissions dropped to 0.47 lb/MBtu which is slightly lower than the 0.50 lb/MBtu shown for the short-term data. The annual and 30-day average achievable NO_x emissions were determined to be 0.55 and 0.64 lb/MBtu, respectively, for the load scenario experienced during the Phase 3A, long-term test period. Based on the long-term test results for Phase 3A, at full-load the low NO_x burners (LNB) retrofit resulted in a NO_x reduction of 48 percent from baseline, while at 300 MW the reduction was approximately 50 percent. A series of tests was also conducted to evaluate the effects of various burner equipment settings and mill coal flow biasing on both NO_x and LOI emissions.

5689 (DOE/PC/93251–T1-Vol.2) **A study of toxic emissions from a coal-fired power plant: Niles Station Boiler No. 2. Volume 2, Appendices: Final report.** Battelle Columbus Operations, OH (United States). Jun 1994. 377p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC93251. Order Number DE94016051. Source: OSTI; NTIS; GPO Dep.

Volume 2 contains appendices for: process data log sheets from Nile boiler 2; auditing; sampling protocol; field sampling data sheets; quality assurance/quality control; analytical protocol; and uncertainty analysis.

5690 (DOE/PC/93251–T3-Vol.1) **A study of toxic emissions from a coal-fired power plant utilizing the SNOX innovative clean coal technology demonstration. Volume 1, Sampling/results/special topics: Final report.** Battelle Columbus Operations, OH (United States). Jul 1994. 364p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC93251. Order Number DE94018832. Source: OSTI; NTIS; GPO Dep.

This study was one of a group of assessments of toxic emissions from coal-fired power plants, conducted for DOE during 1993. The motivation for those assessments was the mandate in the 1990 Clean Air Act Amendments that a study be made of emissions of hazardous air pollutants (HAPs) from electric utilities. The report is organized in two volumes. Volume 1: Sampling describes the sampling effort conducted as the basis for this study; Results presents the concentration data on HAPs in the several power plant streams, and reports the results of evaluations and calculations conducted with those data; and Special Topics report on issues such as comparison of sampling methods and vapor/solid distributions of HAPs. Volume 2: Appendices include quality assurance/quality control results, uncertainty analysis for emission factors, and data sheets. This study involved measurements of a variety of substances in solid, liquid, and gaseous samples from input, output, and process streams at the Innovative Clean Coal Technology Demonstration (ICCT) of the Wet Sulfuric Acid-Selective Catalytic Reduction (SNOX) process. The SNOX demonstration is being conducted at Ohio Edison's Niles Boiler No. 2 which uses cyclone burners to burn bituminous coal. A 35 megawatt slipstream of flue gas from the boiler is used to demonstrate SNOX. The substances measured at the SNOX process were the following: 1. Five major and 16 trace elements, including mercury, chromium, cadmium, lead, selenium, arsenic, beryllium, and nickel; 2. Acids and corresponding anions (HCl, HF, chloride, fluoride, phosphate, sulfate); 3. Ammonia and cyanide; 4. Elemental carbon; 5. Radionuclides; 6. Volatile organic compounds (VOC); 7. Semi-volatile compounds (SVOC) including polynuclear aromatic hydrocarbons (PAH); and 8. Aldehydes.

5691 (DOE/PC/93251–T3-Vol.2) **A study of toxic emissions from a coal-fired power plant utilizing the SNOX innovative clean coal technology demonstration. Volume 2, Appendices: Final report.** Battelle Columbus Operations, OH (United States). Jul 1994. 411p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-93PC93251. Order Number DE94018833. Source: OSTI; NTIS; GPO Dep.

This volume contains the following appendices: Log sheets of SNOX and boiler No. 2 operating conditions, July 18, 19, 21–24, 1993; auditing; sampling protocol; field sampling data sheets; QA/QC; analytical protocol; and uncertainty analysis.

5692 (DOE/PC/94221–T1) **Control of trace metal emissions during coal combustion. Technical progress report, July 1, 1994–September 30, 1994.** Ho, T.C. Lamar Univ., Beaumont, TX (United States). Dept. of Chemical Engineering. Oct 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-94PC94221. Order Number DE95004307. Source: OSTI; NTIS; GPO Dep.

Emissions of toxic trace metals in the form of metal fumes or submicron particulates from a coal-fired combustion source have received greater environmental and regulatory concern over the past years. Current practice of controlling these emissions is to collect them at the cold-end of the process by air-pollution control devices (APCDS) such as electrostatic precipitators and baghouses. However, trace metal fumes may not always be effectively collected by these devices because the formed fumes are extremely small. The proposed research is to explore the opportunities for improved control of toxic trace metal emissions, alternatively, at the hot-end of the coal combustion process, i.e., in the combustion chamber. The technology proposed is to prevent the metal fumes from forming during the process. Specifically, the technology is to employ suitable sorbents to (1) reduce the amount of metal volatilization during combustion and (2) capture volatilized metal vapors. The objectives of the project are to demonstrate the technology and to characterize the metal capture process during coal combustion in a fluidized bed combustor. Specifically, the following progress has been made during this performance period from July 1, 1994 through September 30, 1994: (1) Literature Survey - Pertinent literature related to the project has been thoroughly surveyed and efforts have been devoted to collect them; (2) Experimental Set-up - A fluidized bed combustor has been set-up for the proposed coal combustion experiments; (3) Personnel Training - Students have been trained to operate the fluidized bed combustor and the Perkin Elmer Model 2100 Atomic Absorption Spectrophotometer for metal measurement; (4) Coal Sample Ordering - Several representative coal samples have been ordered and received from the DOE Coal Sample Bank managed by the Pennsylvania State University.

5693 (OCDO–94018418) **Pilot-scale testing of a new sorbent for combined SO_2/NO_x removal. Final report.** Nelson, S. Jr. (Sorbent Technologies Corp., Twinsburg, OH (United States)). Ohio Coal Development Office, Columbus, OH (United States); Sorbent Technologies Corp., Twinsburg, OH (United States). Jun 1994. 117p. Sponsored by Ohio State Government, Columbus, OH (United States). Grant CDO/D-89-11. Source: OSTI; Ohio Coal Development Office, 77 S. High St., P.O. Box 1001, Columbus, OH 43266-0001.

A new regenerable sorbent concept for SO_2 and NOx removal was pilot-tested at Ohio Edison's Edgewater generating station at a 1.5 to 2-MW(e) level. A radial panel-bed filter of a new dry, granular sorbent was exposed to flue gas and regenerated in an experimental proof-of-concept program. The project was successful in demonstrating the new sorbent's ability to achieve 90% SO_2 removal, 30% NOx removal, and over 80% removal of residual particulates with realistic approach temperatures and low pressure drops. Based on the results of this project, the retrofit cost of this technology is expected to be on the order of $400 per ton of SO_2 and $900 per ton of NOx removed. This assumes that gas distribution is even and methane regeneration is used for a 30% average utilization. For a 2.5%-sulfur Ohio coal, this translates to a cost of approximately $17 per ton of coal. Two by-product streams were generated in the process that was tested: a solid, spent-sorbent stream and a highly-concentrated SO_2 or elemental-sulfur stream. While not within the scope of the project, it was found possible to process these streams into useful products. The spent sorbent materials were shown to be excellent substrates for soil amendments; the elemental sulfur produced is innocuous and eminently marketable.

2004 Health and Safety

Refer also to citation(s) 4995, 4996, 4997, 4998, 4999, 6606

2005 Environmental Aspects

Refer also to citation(s) 4955, 6054, 6055

2006 Economic, Industrial, and Business Aspects

Refer also to citation(s) 5669, 6054, 6055

21 NUCLEAR POWER REACTORS AND ASSOCIATED PLANTS

Refer also to citation(s) 5907, 5908, 5910, 5920

5694 (IAEA-TECDOC–763) **Pre-OSART mission highlights. 1988-1990.** International Atomic Energy Agency, Vienna (Austria). Sep 1994. 119p. Order Number DE95611137. Source: OSTI; NTIS (US Sales Only); INIS.

The IAEA Pre-Operational Safety Review Teams (Pre-OSART) programme is part of the Operational Safety Review teams (OSART) programme and provides advice and assistance to Member States for enhancing the operational safety of nuclear power plants. OSART and Pre-OSART reviews are available to all countries with nuclear power plants in operation or approaching operation. Most of these countries have participated in the programme, by hosting one or more OSART or Pre-OSART missions or by making experts available to participate in missions. This document, which summarizes the finding of Pre-OSART reviews, covers the period from January 1988 to December 1990, and it is intended that further such documents will be prepared to cover subsequent Pre-OSART reviews.

2101 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled

Refer also to citation(s) 5196, 5721, 5748, 5883, 5887, 5888, 5891, 5894, 5895, 5913, 5915, 5918, 5921, 5922, 5923, 5924, 5926, 5950, 5952, 5955, 5959, 5960, 5963

5695 (NUREG/CP–0133-Vol.1, pp. 349-361) **Individual plant examination program aspirations and achievements.** Flack, J.H. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

An Individual Plant Examination (IPE) is a systematic examination of a nuclear power plant for vulnerabilities, or risk significant contributors. By mid 1994, all licensees of commercial nuclear power plants will have performed an IPE on their units. To date, the NRC staff has received sixty-three (80%) of the seventy-eight expected IPE submittals. Twelve IPE reviews are now complete, with twenty-two in various stages of review. This paper provides a preliminary overview and comparison of licensees IPEs to Commission objectives. Insights and findings stemming from the review program are also presented.

5696 (NUREG/CP–0133-Vol.1, pp. 363-373) **Handbook of methods for risk-based analysis of technical specification requirements.** Samanta, P.K. (Brookhaven National Lab., Upton, NY (United States)); Vesely, W.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Technical Specifications (TS) requirements for nuclear power plants define the Limiting Conditions for Operation (LCOs) and Surveillance Requirements (SRs) to assure safety during operation. In general, these requirements were based on deterministic analysis and engineering judgments. Experiences with plant operation indicate that some elements of the requirements are unnecessarily restrictive, while others may not be conducive to safety. Improvements in these requirements are facilitated by the availability of plant specific Probabilistic Safety Assessments (PSAs). The use of risk and reliability-based methods to improve TS requirements has gained wide interest because these methods can: Quantitatively evaluate the risk and justify changes based on objective risk arguments; Provide a defensible basis for these requirements for regulatory applications. The US NRC Office of Research is sponsoring research to develop systematic risk-based methods to improve various aspects of TS requirements. The handbook of methods, which is being prepared, summarizes such risk-based methods. The scope of the handbook includes reliability and risk-based methods for evaluating allowed outage times (AOTs), action statements requiring shutdown where shutdown risk may be substantial, surveillance test intervals (STIs), defenses against common-cause failures, managing plant configurations, and scheduling maintenances. For each topic, the handbook summarizes methods of analysis and data needs, outlines the insights to be gained, lists additional references, and presents examples of evaluations.

5697 (NUREG/CP–0133-Vol.1, pp. 375-394) **Overview of AEOD's program for trending reactor operational events.** Baranowsky, P.W. (Nuclear Regulatory Commission, Washington, DC (United States)); O'Reilly, P.D.; Rasmuson, D.M.; Houghton, J.R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

This paper presents an overview of the trending program being performed by AEOD. The major elements of the program include: (1) system and component reliability trending and analysis, (2) special data collection and analysis (e.g., IPE and PRA component failure data, common cause failure event data), (3) risk assessment of safety issues based on actual operating experience, (4) Accident Sequence Precursor (ASP) Program, and (5) trending US industry risk. AEOD plans to maintain up-to-date safety data trends for selected high risk or high regulatory profile components, systems, accident initiators, accident sequences, and regulatory issues. AEOD will also make greater use of PRA insights and perform limited probabilistic safety assessments to evaluate the safety significance of qualitative results. Examples of a system study and an issue evaluation are presented, as well as a summary of the common cause failure event database.

5698 (NUREG/CP–0133-Vol.1, pp. 549-562) **RELAP5/MOD3 code coupling model.** Martin, R.P. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Johnsen, G.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. Contract L2537. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

A new capability has been incorporated into RELAP5/MOD3 that enables the coupling of RELAP5/MOD3 to other computer codes. The new capability has been designed to support analysis of the new advanced reactor concepts. Its user features rely solely on new RELAP5 "styled" input and the Parallel Virtual Machine (PVM) software, which facilitates process management and distributed communication of multiprocess problems. RELAP5/MOD3 manages the input processing, communication instruction, process synchronization, and its own send and receive data processing. The flexible capability requires that an explicit coupling be established, which updates boundary conditions at discrete time intervals. Two test cases are presented that demonstrate the functionality, applicability, and issues involving use of this capability.

5699 (NUREG/CP–0133-Vol.3, pp. 111-134) **Current results for the NRC's short cracks in piping and piping welds research program.** Wilkowski, G. (Battelle, Columbus, OH (United States)); Krishnaswamy, P. Brust, F.; Francini, R.; Ghadiali, N.; Kilinski, T.; Marschall, C.; Rahman, S.; Rosenfield, A.; Scott, P. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

The overall objective of the Short Cracks in Piping and Piping Welds Program is to verify and improve engineering analyses to predict the fracture behavior of circumferentially cracked pipe under quasi-static loading with particular attention to crack lengths typically used in LBB or flaw evaluation criteria. The program consists of 8 technical tasks as listed below. Task 1 Short through-wall-cracked (TWC) pipe evaluations. Task 2 Short surface-cracked pipe evaluations. Task 3 Bi-metallic weld crack evaluations. Task 4 Dynamic strain aging and crack instabilities. Task 5 Fracture evaluations of anisotropic pipe. Task 6 Crack-opening-area evaluations. Task 7 NRCPIPE Code improvements. Task 8 Additional efforts. Since the last WRSM meeting several additional tasks have been initiated in this program. These are discussed in Task 8. Based on results to date, the first seven tasks have also been modified as deemed necessary. The most significant accomplishments in each of these tasks since the last WRSIM meeting are discussed below. The details of all the results presented here are published in the semiannual reports from this program.

5700 (NUREG/CP–0133-Vol.3, pp. 135-152) **Irradiation-assisted stress corrosion cracking of materials from commercial BWRs: Role of grain-boundary microchemistry.** Chung, H.M. (Argonne National Lab., IL (United States)); Ruther, W.E.; Sanecki, J.E.; Hins, A.G.; Kassner, T.F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Constant-extension-rate tensile tests and grain-boundary analysis by Auger electron spectroscopy were conducted on high- and commercial-purity (HP and CP) Type 304 stainless steel (SS) specimens from irradiated boiling-water reactor (BWR) components to

determine susceptibility to irradiation-assisted stress corrosion cracking (IASCC) and to identify the mechanisms of intergranular failure. The susceptibility of HP neutron absorber tubes to intergranular stress corrosion cracking (IGSCC) was higher than that of CP absorber tubes or CP control blade sheath. Contrary to previous beliefs, susceptibility to intergranular fracture could not be correlated with radiation-induced segregation of impurities such as Si, P, C, N, or S, but a correlation was obtained with grain-boundary Cr concentration, indicating a role for Cr depletion that promotes IASCC. Detailed analysis of grain-boundary chemistry was conducted on neutron absorber tubes that were fabricated from two similar heats of HP Type 304 SS of virtually identical bulk chemical composition but exhibiting a significant difference in susceptibility to IGSCC for similar fluence. Grain-boundary concentrations of Cr, Ni, Si, P, S, and C in the crack-resistant and -susceptible HP heats were virtually identical. However, grain boundaries of the cracking-resistant material contained less N and more B and Li (transmutation product from B) than those of the crack-susceptible material, indicating beneficial effects of low N and high B contents.

5701 (NUREG/CP–0133-Vol.3, pp. 153-175) **Fatigue of carbon and low-alloy steels in LWR environments.** Chopra, O.K. (Argonne National Lab., IL (United States)); Michaud, W.F.; Shack, W.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Fatigue tests have been conducted on A106-Gr B carbon steel and A533-Gr B low-alloy steel to evaluate the effects of an oxygenated-water environment on the fatigue life of these steels. For both steels, environmental effects are modest in PWR water at all strain rates. Fatigue data in oxygenated water confirm the strong dependence of fatigue life on dissolved oxygen (DO) and strain rate. The effect of strain rate on fatigue life saturates at some low value, e.g., between 0.0004 and 0.001%/s in oxygenated water with ~0.8 ppm DO. The data suggest that the saturation value of strain rate may vary with DO and sulfur content of the steel. Although the cyclic stress-strain and cyclic-hardening behavior of carbon and low-alloy steels is distinctly different, the degradation of fatigue life of these two steels with comparable sulfur levels is similar. The carbon steel exhibits pronounced dynamic strain aging, whereas strain-aging effects are modest in the low-alloy steel. Environmental effects on nucleation of fatigue crack have also been investigated. The results suggest that the high-temperature oxygenated water has little or not effect on crack nucleation.

5702 (NUREG/CP–0133-Vol.3, pp. 177-196) **Reliability of NDE - cast stainless steel, SAFT-UT performance, PISC III program status, and evaluation of computer-based UT/ISI systems.** Doctor, S.R. (Pacific Northwest Lab., Richland, WA (United States)); Angel, L.J.; Diaz, A.A.; Harris, R.V. Jr.; Simonen, F.A.; Schuster, G.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC06-76RL01830. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

This paper describes progress associated with three different NRC-funded programs at the Pacific Northwest Laboratory. The topics, cast stainless steel (CSS) and PISC III program status, are activities being conducted in the program entitled "Evaluation and Improvement in Nondestructive Examination Reliability for Inservice Inspection of Light Water Reactors (LWRs)" - FIN No. B2289, the work on SAFT-UT performance is part of the program entitled "Field Validation, Acceptance, and Training of Advanced NDE Technology" - FIN No. B2913, and the final activity is part of the program entitled "Evaluation of Computer-Based NDE Techniques and Regional Support of Inspection Activities" - FIN No. L1100.

5703 (NUREG/CP–0133-Vol.3, pp. 197-223) **Progress on risk-based inspection guidelines: Application of Surry-1 pilot study to improved inservice inspection plans.** Simonen, F.A. (Pacific Northwest Laboratory, Richland, WA (United States)); Vo, T.V.; Phan, H.K.; Khaleel, M.A.; Gore, B.F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC06-76RL01830. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

This paper reports on risk-based studies being performed at Pacific Northwest Laboratory (PNL) for NRC as part of a research program entitled Evaluation and Improvement in Nondestructive Examination Reliability for Inservice Inspection of Light Water Reactors (LWRs). The studies at PNL have been carried on in cooperation with efforts by the ASME Research Task Force on Risk-Based Inspection Guidelines, and with a newly formed Section XI Working Group on Implementation of Risk-based inspection. The objective of the work described in this paper is to explicitly quantify the factors (including inservice inspection) that govern the risks (core damage frequency) due to structural failures of pressure boundary components. Having identified the most risk significant components by using the risk-based methods, the results are being applied to develop improved inspection strategies (what, when and by what method). Following a discussion of on-going efforts in the area of risk-based inspection, this paper describes structural reliability models developed at PNL to evaluate the benefits of alternative inspection strategies.

5704 (NUREG/CP–0133-Vol.3, pp. 225-236) **Detection and effects of pump low-flow operation.** Casada, D.A. (Oak Ridge National Lab., TN (United States)); Greene, R.H. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Operating experience and previous studies performed for the Nuclear Plant Aging Research Program have shown that a significant cause of pump problems and failures can result from low-flow operation. Operation at low-flow rates can create unstable flows within the pump impeller and casing. This condition can result in an increased radial and axial thrust on the rotor, which in turn causes higher shaft stresses, increased shaft deflection, and potential bearing and mechanical seal problems. Two of the more serious results of low-flow pump operation are cavitation and recirculation. Both of these conditions can be characterized by crackling sounds that accompany a substantial increase in vibration and noise level, and a reduction in total head and output capacity. Cavitation is the formation and subsequent collapse of vapor bubbles in any flow that is at an ambient pressure less than the vapor pressure of the liquid medium. It is the collapse of these vapor bubbles against the metal surfaces of the impeller or casing that causes surface pitting, erosion, and deterioration. Pump recirculation, reversal of a portion of the flow back through the impeller, can be potentially more damaging than cavitation. If located at the impeller eye, recirculation damages the inlet areas of the casing. At the impeller tips, recirculation alters the outside diameter of the impeller. If recirculation occurs around impeller shrouds, it damages thrust bearings. Recirculation also erodes impellers, diffusers, and volutes and causes failure of mechanical seals and bearings. This paper reports on a utility pump failure cause by low-flow induced phenomena. ORNL has continued to investigate the results of low-flow

pump operations by evaluating the types of measurements and diagnostic techniques that are currently used by licensees to detect pump degradation.

5705 (NUREG/CP–0133-Vol.3, pp. 237-255) **Understanding aging in containment cooling systems.** Lofaro, R.J. (Brookhaven National Lab., Upton, NY (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

A study has been performed to assess the effects of aging in nuclear power plant containment cooling systems. Failure records from national databases, as well as plant specific data were reviewed and analyzed to identify aging characteristics for this system. The predominant aging mechanism were determined, along with the most frequently failed components and their associated failure modes. This paper discusses the aging mechanisms present in the containment spray system and the containment fan cooler system, which are two systems used to provide the containment cooling function. The failure modes, along with the relative frequency of each is also discussed.

5706 (NUREG/CP–0133-Vol.3, pp. 257-267) **Phase I aging assessment of nuclear air-treatment system HEPA filters and adsorbers.** Winegardner, W.K. (Pacific Northwest Lab., Richland, WA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC06-76RL01830. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

A Phase I aging assessment of high-efficiency particulate air filters and activated carbon gas adsorption units was performed by the Pacific Northwest Laboratory as part of the U.S. Nuclear Regulatory Commission's Nuclear Plant Aging Research Program. Information was compiled concerning design features; failure experience; aging mechanisms, effects, and stressors; and monitoring methods. Over 1100 failures, or 12 percent of the filter installations, were reported as part of a U.S. Department of Energy survey. Investigators from other laboratories have suggested that aging could have contributed to over 80 percent of these failures. Several instances of impaired performance as the result of the premature aging of carbon were reported. Filter aging mechanisms range from those associated with particle loading to reactions that alter properties of gaskets. Mechanisms that can lead to impaired adsorber performance include the loss of potentially available active sites as a result of the adsorption of moisture or pollutants. Stressors include heat, moisture, radiation and airborne particles and contaminants.

5707 (NUREG/CP–0133-Vol.3, pp. 269-281) **Prioritization of motor operated valves based on risk importances.** Vesely, W.E. (Science Application Interanational Corp., Dublin, OH (United States)); Weidenhamer, G.H. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

In response to Generic Letter 89-10 which recommends testing of motor operated valves (MOVs), the use of probabilistic risk assessments is evaluated as a tool for prioritizing MOV tests and for determining test schedules. A PRA-based prioritization of MOVs can potentially identify those MOVs which are important to risk and which optimize testing resources. In previous research carried out under the Nuclear Plant Aging Research (NPAR) Program, PRA-based approaches have been developed to prioritize components when multiple degradations and common cause failures could exist. These degradation and failure scenarios are similar to those described in Generic Letter 89-10. Using the NPAR work as a basis, criteria are defined for validly applying a PRA to assist in developing a response to Generic Letter 89-10. Considerations for satisfying the criteria are described, and a validation approach is presented. Examples of PRA application are also illustrated.

5708 (NUREG/CP–0133-Vol.3, pp. 283-306) **Aging management of light water reactor concrete containments.** Shah, V.N. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Hookhman, C.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

This paper evaluates aging of light water reactor concrete containments and identifies three degradation mechanisms that have potential to cause widespread aging damage after years of satisfactory experience: alkali-silica reaction, corrosion of reinforcing steel, and sulfate attack. The evaluation is based on a comprehensive review of the relevant technical literature. Low-alkali cement and slow-reacting aggregates selected according to ASTM requirements cause deleterious alkali-silica reactions. Low concentrations of chloride ions can initiate corrosion of the reinforcing steel if the hydroxyl ions are sufficiently reduced by carbonation, leaching, or magnesium sulfate attack. Magnesium sulfate attack on concrete can cause loss of strength and cementitious properties after long exposure. Techniques to detect and mitigate these long-term aging effects are discussed.

5709 (NUREG/CP–0133-Vol.3, pp. 307-330) **Probabilistic-based evaluation of design rules for components affected by intersystem LOCAs.** Ware, A.G. (Idaho National Engineering Lab., Idaho Falls, ID (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

The methodology outlined in NUREG/CR-5603 was used to evaluate (on a probabilistic basis) design rules for systems in advanced light water reactors (ALWRs) that could be subjected to intersystem loss-of-coolant accidents (ISLOCAs). The methodology is intended for piping elements, flange connections, on-line pumps and valves, and heat exchangers. The NRC has directed that design rules be evaluated at 350°F for BWR and PWR pressures of 1025 and 2235 psig, respectively, and has established a goal of 90% probability that system rupture will not occur during an ISLOCA event. The results of the calculations show that components designed for a pressure of 0.4 of the reactor coolant system operating pressure will satisfy the NRC survival goal in most cases. Specific recommendations for BWR and PWR applications are made.

5710 (NUREG/CP–0133-Vol.3, pp. 331-356) **Structural aging program approach to providing an improved basis for aging management of safety-related concrete structures.** Naus, D.J. (Oak Ridge National Lab., TN (United States)); Oland, C.B.; Ellingwood, B. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information*

Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings. 433p. Source: OSTI; NTIS; INIS; GPO.

The Structural Aging (SAG) Program is being conducted at the Oak Ridge National Laboratory (ORNL) for the United States Nuclear Regulatory Commission (USNRC). The SAG Program is addressing the aging management of safety-related concrete structures in nuclear power plants for the purpose of providing improved technical bases for their continued service. The program is organized into four task: Program Management, Materials Property Data Base, Structural Component Assessment/Repair Technologies, and Quantitative Methodology for Continued Service Determinations. Objectives and a summary of recent accomplishments under each of these tasks are presented.

5711 (NUREG/CP–0133-Vol.3, pp. 357-380) **Experiments to evaluate behavior of containment piping bellows under severe accident conditions.** Lambert, L.D. (Sandia National Lab., Albuquerque, NM (United States)); Parks, M.B. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC04-94AL85000. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Bellows are an integral part of the containment pressure boundary in nuclear power plants. They are used at piping penetrations to allow relative movement between piping and the containment wall. In a severe accident they may be subjected to high pressure and temperature, and a combination of axial and lateral deflections. A test program to determine the leak-tight capacity of containment penetration bellows is being conducted at Sandia National Laboratories, Albuquerque, New Mexico. Several different bellows geometries, representative of actual containment bellows, are being subjected to extreme deflections along with pressure and temperature loads. The bellows geometries and loading conditions are described along with the testing apparatus and procedures. A total of thirteen tests have been conducted. The test showed that bellows are capable of withstanding relatively large deformations, up to, or near, the point of full compression before developing leakage. The test data is presented and discussed.

5712 (NUREG/CP–0133-Vol.3, pp. 381-385) **Guidelines for seismic qualification by experience in ALWRs.** Bandyopadhyay, K.K. (Brookhaven National Lab., Upton, NY (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

The methodologies and acceptance criteria for seismic qualification of equipment are provided in IEEE Std. 344 endorsed by the Nuclear Regulatory Commission (NRC) in the Standard Review Plan. The IEEE Standard allows seismic qualification by use of the similarity analysis method. Data available from past earthquake events or vibration tests can be used in this regard. The nuclear industry has collected a vast amount of earthquake experience and test data in the last decade, and is planning to use it for seismic qualification of equipment in advanced light water reactor (ALWR) plants. This paper discusses the existing data bases including their limitations and describes the ways these data bases can be used for equipment qualification in ALWR plants.

5713 (NUREG/CP–0133-Vol.3, pp. 387-400) **Large-scale seismic test program at Hualien, Taiwan.** Tang, H.T. (Electric Power Research Institute, Palo Alto, CA (United States)); Fong, B.E.; Graves, H.L.; Liao, Y.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

The large-scale seismic test (LSST) program at Hualien, Taiwan is a follow-on to the soil-structure interaction (SSI) experiments at Lotung, Taiwan. The Electric Power Research Institute (EPRI) and the Taiwan Power Company (Taipower) organized a consortium to conduct the program and took the lead in planning and managing the program. Other organizations participating in the consortium that are providing cofunding, cost-sharing and technical as well as management input to the LSST program are: the U.S. Nuclear Regulatory Commission (NRC), the Central Research Institute of Electric Power Industry (CRIEPI), the Tokyo Electric Power Company (TEPCO), the Commissariat A L'Energie Atomique (CEA), the Electricite de France (EdF), Framatome, the Korea Electric Power Corporation (KEPCO), the Korea Institute of Nuclear Safety (KINS) and the Korea Power Engineering Company (KOPEC). The LSST was initiated in January 1990 and is envisioned to monitor and collect earthquake data for five years following the completion of the test facility in 1993. The goal of this program is to collect real earthquake induced soil structure data in order to evaluate computer codes used in SSI analysis of nuclear power plant structures. A major task completed in 1993 was the construction of a 1/4 scale model of a reinforced concrete containment with instrumentation located on the structure and in the field along a three dimensional strong ground motion array. Also to date two forced vibration tests (FVT) have been conducted, one without backfill and one with backfill. The design of a vertical flat bottom tank has been completed and construction is ongoing. This paper describes progress of the Hualien project with emphasis on the FVT without backfill (FVT-1) and the blind prediction results.

5714 (NUREG/CP–0133-Vol.3, pp. 401-411) **Integral testing of relays and circuit breakers.** Bandyopadhyay, K.K. (Brookhaven National Lab., Upton, NY (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Among all equipment types considered for seismic qualification, relays have been most extensively studied through testing due to a wide variation of their designs and seismic capacities. A temporary electrical discontinuity or "chatter" is the common concern for relays. A chatter duration of 2 milliseconds is typically used as an acceptance criterion to determine the seismic capability of a relay. Many electrical devices, on the other hand, receiving input signals from relays can safely tolerate a chatter level much greater than 2 ms. In Phase I of a test program, Brookhaven National Laboratory performed testing of many relay models using the 2-ms chatter criterion. In Phase II of the program, the factors influencing the relay chatter criterion, and impacts of relay chatter on medium and low voltage circuit breakers and lockout relays were investigated. This paper briefly describes the Phase II tests and presents the important observations.

5715 (NUREG/CP–0133-Vol.3, pp. 413) **Development of an improved methodology for probabilistic seismic hazard analysis.** Budnitz, R.J. (Future Resources Associates, Inc., Berkeley, CA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3,*

Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings. 433p. Source: OSTI; NTIS; INIS; GPO.

In the late 1980s, the methodology for performing probabilistic seismic hazard analysis (PSHA) was exercised extensively for eastern-U.S. nuclear power plant sites by the Electric Power Research Institute (EPRI) and Lawrence Livermore National Laboratory (LLNL) under NRC sponsorship. Unfortunately, the seismic-hazard-curve results of these two studies differed substantially for many of the eastern reactor sites, which has motivated all concerned to revisit the approaches taken. This project is that revisitation.

5716 (NUREG/CR–0137-Vol.2, pp. 341-346) **Verifying check valve position with radiography.** Scott, S.R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

This paper presents the results of a program used at Grand Gulf Nuclear Station for verifying the positions of check valve disks using radiography. Valve position verification using radiographs meets the requirements of Section XI, IWV-3522, and OM Code, ISTC 4.5.4, for verifying disk position by "other positive means" when more typical methods such as flow, differential pressure, and external position indicators cannot be used. The method is particularly suitable for small valves (up to 6-in. nominal pipe size) and does not require special preparations, such as removal of insulation. This paper discusses advantages, disadvantages, costs, equipment, and manpower requirements for performing radiography of check valve disks. Sample radiograph images, showing typical internal details, are included.

5717 (NUREG/CR–6303) **Method for performing diversity and defense-in-depth analyses of reactor protection systems.** Preckshot, G.G. (Lawrence Livermore National Lab., CA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Reactor Controls and Human Factors; Lawrence Livermore National Lab., CA (United States). Dec 1994. 36p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. (UCRL-ID–119239). Source: OSTI; NTIS; GPO; INIS.

The purpose of this NUREG is to describe a method for analyzing computer-based nuclear reactor protection systems that discovers design vulnerabilities to common-mode failure. The potential for common-mode failure has become an important issue as the software content of protection systems has increased. This potential was not present in earlier analog protection systems because it could usually be assumed that common-mode failure, if it did occur, was due to slow processes such as corrosion or premature wear-out. This assumption is no longer true for systems containing software. It is the purpose of the analysis method described here to determine points of a design for which credible common-mode failures are uncompensated either by diversity or defense-in-depth.

5718 (PNL–8425) **Physical characteristics of non-fuel assembly reactor components.** Hawkes, E.C. Pacific Northwest Lab., Richland, WA (United States). Sep 1994. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95000972. Source: OSTI; NTIS; INIS; GPO Dep.

The primary objective of this report is to enhance the utility of the Characteristics Data Base (CDB). This has been accomplished by providing a pictorial representation of the principal non-fuel assembly (NFA) components along with a tabular summary of key information about each type of component. This report is intended for use as an adjunct to the CDB. Toward this end, the report may be used either as a complement to the detailed descriptions in the CDB, or as a stand-alone document that acts as an illustrated abstract of the CDB. Line drawings of major NFA components are included. Data not provided in the CDB are also included. Summary descriptions of each component are given in tabular format.

5719 (SAND–94-0135) **1-Dimensional simulation of thermal annealing in a commercial nuclear power plant reactor pressure vessel wall section.** Nakos, J.T.; Rosinski, S.T.; Acton, R.U. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 167p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95005063. Source: OSTI; NTIS; INIS; GPO Dep.

The objective of this work was to provide experimental heat transfer boundary condition and reactor pressure vessel (RPV) section thermal response data that can be used to benchmark computer codes that simulate thermal annealing of RPVS. This specific protect was designed to provide the Electric Power Research Institute (EPRI) with experimental data that could be used to support the development of a thermal annealing model. A secondary benefit is to provide additional experimental data (e.g., thermal response of concrete reactor cavity wall) that could be of use in an annealing demonstration project. The setup comprised a heater assembly, a 1.2 in x 1.2 m x 17.1 cm thick [4 ft x 4 ft x 6.75 in] section of an RPV (A533B ferritic steel with stainless steel cladding), a mockup of the "mirror" insulation between the RPV and the concrete reactor cavity wall, and a 25.4 cm [10 in] thick concrete wall, 2.1 in x 2.1 in [10 ft x 10 ft] square. Experiments were performed at temperature heat-up/cooldown rates of 7, 14, and 28°C/hr [12.5, 25, and 50°F/hr] as measured on the heated face. A peak temperature of 454°C [850°F] was maintained on the heated face until the concrete wall temperature reached equilibrium. Results are most representative of those RPV locations where the heat transfer would be 1-dimensional. Temperature was measured at multiple locations on the heated and unheated faces of the RPV section and the concrete wall. Incident heat flux was measured on the heated face, and absorbed heat flux estimates were generated from temperature measurements and an inverse heat conduction code. Through-wall temperature differences, concrete wall temperature response, heat flux absorbed into the RPV surface and incident on the surface are presented. All of these data are useful to modelers developing codes to simulate RPV annealing.

5720 (STUK-B-YTO–123) **Operation of Finnish nuclear power plants. Quarterly report 1st quarter, 1994.** Tossavainen, K. (ed.). Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). Oct 1994. 22p. Order Number DE95611141. Source: OSTI; NTIS; INIS.

Published also in Finnish as report number STUK-B-YTO–119.

Quarterly reports on the operation of the Finnish NPPs describe nuclear and radiation safety related events and observations which the Finnish Centre for Radiation and Nuclear Safety considers safety significant. Safety improvements at the plants and general matters relating to the use of nuclear energy are also reported. A summary of the radiation safety of the plant personnel and the environment, and tabulated data on the plant's production and load factors are also given. (4 figs., 5 tabs.).

2102 Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled

Refer also to citation(s) 5196, 5695, 5696, 5697, 5698, 5699, 5701, 5702, 5703, 5704, 5705, 5706, 5707, 5708, 5709, 5710, 5711, 5712, 5713, 5714, 5715, 5717, 5718, 5719, 5720, 5748, 5887, 5888, 5894, 5895, 5896, 5898, 5912, 5913, 5914, 5915, 5916, 5918, 5919, 5924, 5926, 5950, 5952, 5954, 5955, 5959, 5963

5721 (NUREG/CP–0133-Vol.1, pp. 339-348) **IPE data base structure and insights.** Lehner, J. (Brookhaven National Lab., Upton, NY (United States)); Youngblood, R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research;*

probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs. 586p. Source: OSTI; NTIS; INIS; GPO.

A data base (the "IPE Insights Data Base"), has been developed that stores data obtained from the Individual Plant Examinations (IPEs) which licensees of nuclear power plants are conducting in response to the Nuclear Regulatory Commission's (NRC) Generic Letter GL88-20. The data base, which is a collection of linked dBase files, stores information about individual plant designs, core damage frequency, and containment performance in a uniform, structured way. This data base can be queried and used as a computational tool to derive insights regarding the plants for which data is stored. This paper sets out the objectives of the IPE Insights Data Base, describes its structure and contents, illustrates sample queries, and discusses possible future uses.

5722 (NUREG/CP–0133-Vol.3, pp. 27-79) **Heavy-section steel irradiation program progress - recent results from Midland low upper-shelf weld studies.** Corwin, W.R. (Oak Ridge National Lab., TN (United States)); Nanstad, R.K.; McCabe, D.E.; Iskander, S.K. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Low upper-shelf weld metal removed from two major structural welds in the vessel of the Midland Unit 1 Reactor is being examined to establish its variation in chemistry and fracture properties in the unirradiated condition and to investigate its response to neutron irradiation. Both beltline and nozzle course welds were examined throughout their thickness at a number of different locations. Even though all the weld metal examined carries the identical WF-70 designation, its bulk copper content ranged widely, from 0.21 to 0.46 wt%. Its dropweight nil-ductility transition temperatures ranged from -40 to -60°C (-40 and -76°F). The values of the nil-ductility reference temperature (RT_{NDT}) are all controlled by Charpy impact behavior and varied from -20 to 37°C (-4 to 99°F) while the Charpy upper-shelf energies varied from 77 to 108 J (57 to 80 ft-lb). A newly proposed method for identifying a transition temperature from fracture mechanics-based data established a difference in transition temperatures between nozzle course and beltline weld metal of 27°C (49°F). Crack-arrest toughness values were determined for the beltline weld. The ASME K_{Ic} and K_{Ia} curves were shown to adequately bound all experimental fracture toughness and crack-arrest data, respectively, using the full range of experimentally determined values of RT_{NDT}, but with a relatively large amount of uncertainty in the margin between the data and the toughness curves. The irradiation of the Midland weld is in progress for exposures between 5 $x10^{18}$ and 5 x 10^{19} neutrons/cm^2 to examine fluence effects over this range.

5723 (NUREG/CP–0137-Vol.1, pp. 159-178) **Ten-year rollover of San Onofre inservice testing program for pumps and valves to OM-6 and OM-10.** Croy, P.A.; Fischetti, S.; Chiang, D.; Schofield, P.; Barney, D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Pump and Valve Inservice Testing (IST) Program Sat San Onofre, Units 2 and 3, was updated for the second 120-month interval from August 1993 to April 1994. The U.S. Nuclear Regulatory Commission (USNRC) approved the OM-6 and OM-10 Codes in mid-1992. The project for the rollover to these new Codes included several elements: (a) a review of the differences between IWV/IWP and OM-6/OM-10, (b) a comprehensive audit of the IST Program scope for valves, (c) creation of the program and supporting basis documents, the Relief Requests, and implementing procedures, (d) interdivisional coordination, (e) submittal to the USNRC, and (f) training. Subsections IWV and IWP have been used and essentially unchanged for over a decade. The new Code (Parts 1, 6, and 10 called OM-1, OM-6, and OM-10) includes several significant changes from the old Code. Our group identified these differences and drafted revised and reorganized Inservice Testing (IST) Program documents. We also considered USNRC Generic Letter 89-04 (GL 89-04), "Guidance on Developing Acceptable Inservice Testing Programs", and NUREG-1482, Guidelines for Inservice Testing at Nuclear Power Plants, while revising the program. There were six pump relief requires and 13 valve relief requests in the program for the first 10-year interval. For the revised program we needed only one pump relief request (and no valve relief requests). Converting to the 1989 edition of the ASME Code did not require changes to the technical specifications. We revised our Updated Final Safety Analysis Report (UFSAR) to reflect the IST Program for the second 10-year interval. UFSAR changes were minor, consisting of updated references to the Code edition and 10 CFR 50.55a(f), "Inservice Testing Requirements".

5724 (NUREG/CR–0137-Vol.2, pp. 45-53) **Pressure locking of gate valves-French experience and solutions.** Coppolani, P.; Grenet, M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Pressure locking resulting from liquid entrapment affected residual heat removal suction isolation wedge gate valves in French 900-MW pressurized water reactors. Drilling of the upstream seats was insufficient to prevent overpressurization from thermal hydraulic "dead leg" effects in the upstream lines. Heating of steam condensate in the bonnet was the cause of refusal to open of the 1300-MW main steam isolation wedge gate valves. Early switch-off and incomplete closure from the stem "piston" effect on the double disk gate valves was caused by systematic leakage. Also, pressure locking from differential pressure is a concern for double-disc sump isolation valves that must be opened following a loss-of-coolant accident. Therefore, Electricite de France is now implementing a systematic program to ensure protection of gate valves against pressure locking effects by the addition of external bypass lines on sensitive gate valves that must be active during an accident.

5725 (NUREG/CR–0137-Vol.2, pp. 309-331) **Acoustic emission testing of piston check valves.** Stewart, D.L. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Based on test experience at Comanche Peak Unit 1, an acoustic emission data evaluation matrix for piston check valves has been developed. The degradations represented in this matrix were selected based on Edwards piston check valve failure data reported in the Nuclear Plant Reliability Data System. Evidence to support this matrix was collected from site test data on a variety of valve types. Although still under refinement, the matrix provides three major attributes for closure verification, which have proven useful in developing test procedures for inservice testing and preventing unnecessary disassembly.

2103 Power Reactors, Nonbreeding, Graphite Moderated

Refer also to citation(s) 5091, 5868, 5886, 5898, 7022

5726 (GA-A–21827) **GT-MHR power conversion system: Design status and technical issues.** Etzel, K. (General Atomics, San Diego, CA (United States)); Baccaglini, G.; Schwartz, A.; Hillman, S.; Mathis, D. General Atomics, San Diego, CA (United States). Dec 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89SF17885. (CONF-9411153–3: Development status of modular high temperature reactors and their future role, Petten (Netherlands), 28-30 Nov 1994). Order Number DE95003503. Source: OSTI; NTIS; INIS; GPO Dep.

The Modular Helium Reactor (MHR) builds on 30 years of international gas-cooled reactor experience utilizing the unique properties of helium gas coolant, graphite moderator and coated particle fuel. To efficiently utilize the high temperature potential of the MHR, an innovative power conversion system has been developed featuring an intercooled and recuperated gas turbine. The gas turbine replaces a conventional steam turbine and its many auxiliary components. The Power Conversion System converts the thermal energy of the helium directly into electrical energy utilizing a closed Brayton cycle. The Power Conversion System draws on even more years of experience than the MHR: the world's first closed-cycle plant, fossil fired and utilizing air as working fluid, started operation in Switzerland in 1939. Shortly thereafter, in 1945, the coupling of a closed-cycle plant to a nuclear heat generation system was conceived. Directly coupling the closed-cycle gas turbine concept to a modern, passively safe nuclear reactor opens a new chapter in power generation technology and brings with it various design challenges. Some of these challenges are associated with the direct coupling of the Power Conversion System to a nuclear reactor. Since the primary coolant is also the working fluid, the Power Conversion System has to be designed for reactor radionuclide plateout. As a result, issues like component maintainability and replaceability, and fission product effects on materials must be addressed. Other issues concern the integration of the Power Conversion System components into a single vessel. These issues include the selection of key technologies for the power conversion components such as submerged generator, magnetic bearings, seals, compact heat exchangers, and the overall system layout.

5727 (GA-A–21894) **GT-MHR operations and control.** Rodriguez, C.; Zgliczynski, J.; Pfremmer, D. General Atomics, San Diego, CA (United States). Nov 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89SF17885. (CONF-9411153–1: Development status of modular high temperature reactors and their future role, Petten (Netherlands), 28-30 Nov 1994). Order Number DE95003378. Source: OSTI; NTIS; INIS; GPO Dep.

The Gas Turbine Modular Helium Reactor (GT-MHR) combines features that lead to high thermal efficiencies, cycle simplicity, enhanced safety, and improved economics. It uses a high thermal capacity nuclear core that operates at high temperatures, and a Brayton energy conversion cycle. The high temperature helium from the reactor directly drives a gas turbine and electric generator, which is a process that can achieve a net efficiency in the range of 45% to 48%. Characteristics of the GT-MHR that are particularly important to the development of operation and control schemes for the GT-MHR include the thermal capacity of the core, excess reactivity, negative temperature coefficient of reactivity effects (provided by the fuel and the graphite moderator), Xenon reactivity effects (particularly important for large amplitude power reductions), the inertia of the turbogenerator, the speed of response of the valves that allow helium to be diverted around the core and the turbine for fast power reductions, the rate of helium transfer in and out of the system to accommodate longer term part load operating conditions, and the operating envelopes specified for systems and components. Together, these characteristics and specifications determine time and amplitude response capabilities, and the operating range of the GT-MHR. GT-MHR operation and control schemes must comply with utility requirements, particularly load following requirements, be compatible with GT-MHR characteristics, and lead to compliance with system and component operating limits.

5728 (GA-A–21924) **GT-MHR design, performance, and safety.** Neylan, A.J.; Shenoy, A.; Silady, F.A.; Dunn, T.D. General Atomics, San Diego, CA (United States). Nov 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89SF17885. (CONF-9411153–2: Development status of modular high temperature reactors and their future role, Petten (Netherlands), 28-30 Nov 1994). Order Number DE95003490. Source: OSTI; NTIS; INIS; GPO Dep.

The Gas Turbine-Modular Helium Reactor (GT-MHR) is the result of coupling the evolution of a low power density passively safe modular reactor with key technology developments in the U.S. during the last decade: large industrial gas turbines; large active magnetic bearings; and compact, highly effective plate-fin heat exchangers. This is accomplished through the unique use of the Brayton cycle to produce electricity with the helium as primary coolant from the reactor directly driving the gas turbine electrical generator. This cycle can achieve a high net efficiency in the range of 45% to 48%. In the design of the GT-MHR the desirable inherent characteristics of the inert helium coolant, graphite core, and the coated fuel particles are supplemented with specific design features such as passive heat removal to achieve the safety objective of not disturbing the normal day-to-day activities of the public even for beyond design basis rare accidents. Each GT-MHR plant consists of four modules. The GT-MHR module components are contained within steel pressure vessels: a reactor vessel, a power conversion vessel, and a connecting cross vessel. All vessels are sited underground in a concrete silo, which serves as an independent vented low pressure containment structure. By capitalizing on industrial and aerospace gas turbine development, highly effective heat exchanger designs, and inherent gas cooled reactor temperature characteristics, the passively safe GT-MHR provides a sound technical, monetary, and environmental basis for new nuclear power generating capacity. This paper provides an update on the status of the design, which has been under development on the US-DOE program since February 1993. An assessment of plant performance and safety is also included.

5729 (GA-A–21925) **FSV experience in support of the GT-MHR reactor physics, fuel performance, and graphite.** Baxter, A.M.; McEachern, D.; Hanson, D.L.; Vollman, R.E. General Atomics, San Diego, CA (United States). Nov 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89SF17885. (CONF-9411153–4: Development status of modular high temperature reactors and their future role, Petten (Netherlands), 28-30 Nov 1994). Order Number DE95003492. Source: OSTI; NTIS; INIS; GPO Dep.

The Fort St. Vrain (FSV) power plant was the most recent operating graphite-moderated, helium-cooled nuclear power plant in the United States. Many similarities exist between the FSV design and the current design of the GT-MHR. Both designs use graphite as the basic building blocks of the core, as structural material, in the reflectors, and as a neutron moderator. Both designs use hexagonal fuel elements containing cylindrical fuel rods with coated fuel particles. Helium is the coolant and the power densities vary by less than 5%. Since material and geometric properties of the GT-MHR core am very similar to the FSV core, it is logical to draw upon the FSV experience in support of the GT-MHR design. In the Physics area, testing at FSV during the first three cycles of operation has confirmed that the calculational models used for the core design were very successful in predicting the core nuclear performance from initial cold criticality through power operation and refueling. There was excellent agreement between predicted and measured initial core criticality and control rod positions during startup. Measured axial flux distributions were within 5% of the predicted value at the peak. The isothermal temperature coefficient at zero power was in agreement within 3%, and even the calculated temperature defect over the whole operating range for cycle 3 was within 8% of the measured defect. In the Fuel Performance area, fuel particle coating performance, and fission gas release predictions and an overall plateout analysis were performed for decommissioning purposes. A comparison between predicted and measured fission gas release histories of Kr-85m and Xe-138 and a similar comparison with specific circulator plateout data indicated good agreement between prediction and measured data. Only I-131 plateout data was overpredicted, while Cs-137 data was underpredicted.

5730 (HW–79463) **Notes on heat transfer from rotating machinery components to gases.** Zaloudek, F.R. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 11 Nov 1963. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018250. Source: OSTI; NTIS; GPO Dep.

Recently, there has been much interest in the study of materials and components to be used in high temperature gas blowers and turbines such as used in gas cooled reactor systems. Of fundamental importance to a study of such machinery is the determination of the convective heat transfer rates to the rapidly revolving components–especially to compressor impellers, turbine runners, shafting, and driving motor armatures. The purpose of this report is to summarize and evaluate some of the information available and to apply available methods of analysis to the rotating disk and shaft to obtain usable heat transfer relations. The general characteristics of the flow fields surrounding heated shafts and disks were examined with particular attention given to the critical rotational speeds at which transitions between laminar and turbulent flow occur. A method based upon the basic analogy principles was developed to describe the turbulent heat transfer from a rotating disk subjected to boundary conditions found in practical application. The heat transfer relations developed were used to augment the empirical relationships found in literature and a collection of recommended equations were assembled.

2104 Power Reactors, Nonbreeding, Otherwise Moderated Or Unmoderated

Refer also to citation(s) 5817, 5862, 5863, 5864, 5865, 5869, 5897, 5898, 5931

5731 (SAND–93-2496) **Aluminum-water reflood experiments.** Marshall, B.W. Jr. (Sandia National Labs., Albuquerque, NM (United States)); Teague, W.; Hanks, C. Sandia National Labs., Albuquerque, NM (United States). Dec 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (NPRW-SA–93-1). Order Number DE95004268. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Aluminum-uranium fuels are currently planned for use in the New Production Reactor-Heavy Water Reactor and are used in the K-reactor at the Savannah River Site. During a hypothetical reactor accident in which fuel-melting occurs, molten material would be expected to relocate down through the lower plenum and settle on the lower head in the form of a debris bed and/or molten pool. If Emergency Core Cooling water were unavailable during this period of the accident, decay heat and sensible heat from the relocated material would void the reactor vessel of liquid water, continue heating, and ultimately create a molten pool of U-Al fuel on the lower head. A successful accident management strategy requires an understanding of the coolability and quenching of metallic pools of melt. To this end, four experiments were conducted in which water was poured onto ~10 kg of molten aluminum. Water injection modes considered included sprays, streams (or jets), and a gentle (quiescent) flow of water over the melt pool, providing a full range of water-addition conditions that might be expected during the reflooding of a reactor vessel. Results show that aluminum melt-pools were quenched without explosive interactions occurring. Post-test debris, the recorded temperature data, and the high-speed films showed that mixing of the two fluids and subsequent quenching of the molten aluminum occurred without any signs of energetic interactions between the molten aluminum and water. Data presented leads to the following tentative conclusion: In the absence of an external trigger and at melt temperatures below 1500 K, quiescent aluminum melt-pools can be quenched without explosive interactions.

2105 Power Reactors, Breeding

Refer also to citation(s) 5116, 5818

5732 (ANL/IFR/CP–82836) **Computer imaging of EBR-II handling equipment.** Hansen, L.H.; Peters, G.G. Argonne National Lab., Idaho Falls, ID (United States). Oct 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-941054–1: 8. annual Idaho National Engineering Laboratory (INEL) computing symposium, Idaho Falls, ID (United States), 4-7 Oct 1994). Order Number DE95001453. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes a three-dimensional graphics application used to visualize the positions of remotely operated fuel handling equipment in the EBR-II reactor. The system described in this paper uses actual signals to move a three-dimensional graphics model in real-time in response to movements of equipment in the plant. A three-dimensional (3D) visualization technique is necessary to simulate direct visual observation of the transfers of fuel and experiments into and out of the reactor because the fuel handling equipment is submerged in liquid sodium and therefore is not visible to the operator. This paper will present details on how the 3D model was created and how real-time dynamic behavior was added to each of the moving components.

5733 (CIEMAT–740) **Lace-Espaa experimental programme on the retention of aerosols in water pools.** Marcos Crespo, M.J.; Gomez; Moreno, F. J.; Melches Serrano, I.; Martin Espigares, M.; Lopez Jimenez, J. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 200p. Order Number DE95722416. Source: OSTI; NTIS; INIS.

A matrix of eleven experiments on aerosol retention behaviour in submerged beds and supresion pools in water-cooled reactors under severe accident conditions has been performed, for these experiments, an intermediate scale, multi-purpose facility was set up at CIEMAT (Madrid). The facility includes various systems: aerosol ageneration (CsI), mixing section, injection line and pool-vessel (8 m^3), as well as the corresponding aerosol instrumentation and a process control and data adquisition system. Some parameters have been varied in order to study their influence in the DF: steam/noncondensable ratio in the accidental mixture (0,1 to 0.9) particle size, flow rate (two regimes: bubble and jet) and injector geometry (monoorifice and multiorifice). On the other hand, some parameters have been kept constant along the experiments; pool geometry (diameter, water level), water temperature, pressure in the atmosphere above the water, submergence, injection temperature and injection time. A Rapid decrease in the DF is observed as the proportion of particles measuring les than 1 mum increases. Retention decreases in the case of smaller particles and considerably higher in the case of larger particles. It has been also possible to observe the influence of the injected steam fraction. Experiments with greater fraction than the saturation fraction have greater DF than those ones with smaller fractions. The jet regime with horizontal injection and the multiorifice geometry would appear to show a somewhat higher capacity of retention than those in the bubble regime under similar conditions. It would be necessary to confirm this greater capacity for retention by means of additional experimental data. This work, performed by the LACE-Espaa Consortium, has been carried out in the frame of the European Commission's Shared Cost Action Programme on Reactor Safety 1988-91 on a contractual basis.

5734 (JAERI-M–94-068, pp. 64-75) **Utilization of cross-section covariance data in FBR core nuclear design and cross-section adjustment.** Ishikawa, Makoto (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1994. (CONF-9307182–: Specialists' meeting on covariance data, Tokai (Japan), 15-16 Jul 1993; INDC(JPN)–171/U). In *Proceedings of the specialists' meeting on covariance data.* 95p. Order Number DE94013048. Source: OSTI; NTIS; INIS.

In the core design of large fast breeder reactors (FBRs), it is essentially important to improve the prediction accuracy of nuclear characteristics from the viewpoint of both reducing cost and insuring reliability of the plant. The cross-section errors, that is, covariance data are one of the most dominant sources for the prediction uncertainty of the core parameters, therefore, quantitative evaluation of covariance data is indispensable for FBR core design. The first objective of the present paper is to introduce how the cross-section covariance data are utilized in the FBR core nuclear design works. The second is to delineate the cross-section adjustment study and its application to an FBR design, because

this improved design method markedly enhances the needs and importance of the cross-section covariance data. (author).

2106 Power Reactors, Mobile, Propulsion, Package, and Transportable

Refer also to citation(s) 5824

5735 (LA-UR–94-1688) **An overview of the Nuclear Electric Propulsion Space Test Program (NEPSTP) satellite.** Voss, S.S. (Los Alamos National Lab., NM (United States)); Reynolds, E.L. Los Alamos National Lab., NM (United States). [1994]. 13p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940812–4: 29. intersociety energy conversion engineering conference, Monterey, CA (United States), 7-12 Aug 1994). Order Number DE94013121. Source: OSTI; NTIS; GPO Dep.

Early in 1992 the idea of purchasing a Russian designed and fabricated space reactor power system and integrating it with a US designed satellite went from fiction to reality with the purchase of the first two Topaz II reactors by the Strategic Defense Initiative Organization (now the Ballistic Missile Defense Organization (BMDO). The New Mexico Alliance was formed to establish a ground test facility in which to perform nonnuclear systems testing of the Topaz II, and to evaluate the Topaz 11 system for flight testing with respect to safety, performance, and operability. In conjunction, SDIO requested that the Applied Physics Laboratory in Laurel, MD propose a mission and design a satellite in which the Topaz II could be used as the power source. The outcome of these two activities was the design of the Nuclear Electric Propulsion Space Test Program (NEPSTP) satellite which combines a modified Russian Topaz II power system with a US designed satellite to achieve a specified mission. Due to funding reduction within the SDIO, the Topaz II flight program was postponed indefinitely at the end of Fiscal Year 1993. The purpose of this paper is to present an overview of the NEPSTP mission and the satellite design at the time the flight program ended.

5736 (LA-UR–94-3723) **Water/sand flooded and immersed critical experiment and analysis performed in support of the TOPAZ-II Safety Program.** Glushkov, E.S. (RRC Kurchatov Institute, Moscow (Russian Federation)); Ponomarev-Stepnoi, N.N.; Bubelev, V.G.; Garin, V.P.; Gomin, E.A.; Kompanietz, G.V.; Krutoy, A.M.; Lobynstev, V.A.; Maiorov, L.V.; Polyakov, D.N. Los Alamos National Lab., NM (United States). 1 Nov 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950110–16: 12. symposium on space nuclear power and propulsion, Albuquerque, NM (United States), 8-12 Jan 1995). Order Number DE95003720. Source: OSTI; NTIS; INIS; GPO Dep.

Presented is a brief description of the Narciss-M2 critical assemblies, which simulate accidental water/wet-sand immersion of the TOPAZ-II reactor as well as water-flooding of core cavities. Experimental results obtained from these critical assemblies, including experiments with several fuel elements removed from the core, are shown. These configurations with several extracted fuel elements simulate a proposed fuel-out anticriticality-device modification to the TOPAZ-II reactor. Preliminary computational analysis of these experiments using the Monte Carlo neutron-transport method is outlined. Nuclear criticality safety of the TOPAZ-II reactor with an incorporated anticriticality unit is demonstrated.

5737 (SAND–94-2322C) **The potential of vacuum microelectronics for space reactor applications.** King, D.B.; Fleming, J.G.; Walko, R.J. Sandia National Labs., Albuquerque, NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950110–3: 12. symposium on space nuclear power and propulsion, Albuquerque, NM (United States), 8-12 Jan 1995). Order Number DE95000542. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses matrixed field emission devices which have been fabricated using a modification of standard integrated circuit fabrication techniques. The emitter-to-gate spacing is fixed by the thickness of a deposited oxide and not by photolithographic techniques. Functioning triodes have been fabricated using this deposited oxide spacer approach. Measured emission current to a collector electrically and physically separated from the matrixed emission array follows Fowler-Nordheim behavior. Modeling of the potential field near the emitter and gate structures as well as the emitted electron trajectories with a two-dimensional, Poisson solver, finite-difference code was used to evaluate and improve field emission structures.

2107 Regulation and Licensing

Refer also to citation(s) 5484, 5821, 5893, 5936, 5947, 5956, 5957, 6028, 6029, 6030, 6631

5738 (GAO/RCED–93-153) **Progress toward international agreement to improve reactor safety.** Lieberman, J.I.; Graham, B. General Accounting Office, Washington, DC (United States). Resources, Community and Economic Development Div. 14 May 1993. 17p. Sponsored by General Accounting Office, Washington, DC (United States). Order Number DE95004465. Source: OSTI; NTIS; INIS.

Representatives of nearly one-half of the 114 member states of the International Atomic Energy Agency (IAEA), including the United States, have participated in the development of an international nuclear safety conventions proposed multilateral treaty to improve civil nuclear power reactor safety. A preliminary draft of the convention has been developed (referred to as the draft convention for this report), but discussions are continuing, and when the final convention text will be completed and presented to IAEA member states for signature is uncertain. This report responds to the former and current Chairman's request that we provide information on the development of the nuclear safety convention, including a discussion of (1) the draft convention's scope and objectives, (2) how the convention will be implemented and monitored, (3) the views of selected country representatives on what provisions should be included in the draft convention, and (4) the convention's potential benefits and limitations.

5739 (NUREG–0040-Vol.18-No.3) **Licensee contractor and vendor inspection status report. Quarterly report, July–September 1994: Volume 18, No. 3.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Technical Support. Nov 1994. 113p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO.

This periodical covers the results of inspections performed by the NRC's Special Inspection Branch, Vendor Inspection Section, that have been distributed to the inspected organizations during the period from July through September 1994.

5740 (NUREG–0540-Vol.16-No.7) **Title list of documents made publicly available, July 1–31, 1994. Volume 16, No. 7.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Nov 1994. 316p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This document is a monthly publication containing descriptions of information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes docketed material associated with civilian nuclear power plants and other uses of radioactive materials, and nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. The following indexes are included: Personal Author, Corporate Source, Report Number, and Cross Reference of Enclosures to Principal Documents.

5741 (NUREG–0540-Vol.16-No.8) **Title list of documents made publicly available, August 1–31, 1994. Volume 16, No. 8.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Nov 1994. 387p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This document is a monthly publication containing descriptions of information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes docketed material associated with civilian nuclear power plants and other uses of

radioactive materials and nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. The following indexes are included: Personal Author, Corporate Source, Report Number, and Cross Reference of Enclosures to Principal Documents.

5742 (NUREG–0540-Vol.16-No.10) **Title list of documents made publicly available: October 1–31, 1994. Volume 16, Number 10.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Dec 1994. 300p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

The Title List of Documents Made Publicly Available is a monthly publication. It contains descriptions of the information received and generated by the US Nuclear Regulatory Commission (NRC). This information includes (1) docketed material associated with civilian nuclear power plants and other uses of radioactive materials and (2) nondocketed material received and generated by NRC pertinent to its role as a regulatory agency. As used here, docketed does not refer to Court dockets; it refers to the system by which NRC maintains its regulatory records. This series of documents is indexed by a Personal Author Index, a Corporate Source Index, and a Report Number Index.

5743 (NUREG–0750-Vol.40-Index-1) **Indexes to Nuclear Regulatory Commission issuances: July–September 1994. Volume 40, Index 1.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. 1994. 30p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

Digests and indexes for issuances of the Commission (CLI), the Atomic Safety and Licensing Board Panel (LBP), the Administrative Law Judges (ALJ), the Directors' Decision (DD), and the Denials of Petitions for Rulemaking (DPRM) are presented in this document. These digests and indexes are intended to serve as a guide to the issuances. Information elements common to the cases heard and ruled upon are: case name (owner(s) of facility), full text reference (volume and pagination), issuance number, issues raised by apellants, legal citations (cases, regulations, and statutes), name of facility, docket number, subject matter of issues and/or rulings, type of hearing (for construction permit, operating license, etc.), type of issuance (Memorandum, order, decision, etc.).

5744 (NUREG–0750-Vol.40-No.3) **Nuclear Regulatory Commission issuances, September 1994. Volume 40, No. 3.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. [1994]. 20p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judges (AU), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM).

5745 (NUREG–0940-Vol.13-No.3-Pt.1) **Enforcement actions: Significant actions resolved, reactor licensees. Quarterly progress report, July–September 1994; Volume 13, Number 3, Part 1.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Enforcement. Dec 1994. 307p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This compilation summarizes significant enforcement actions that have been resolved during one quarterly period (July–September 1994) and includes copies of letters, Notices, and Orders sent by the Nuclear Regulatory Commission to reactor licensees with respect to these enforcement actions. It is anticipated that the information in this publication will be widely disseminated to managers and employees engaged in activities licensed by the NRC, so that actions can be taken to improve safety by avoiding future violations similar to those described in this publication.

5746 (NUREG–0940-Vol.13-No.3-Pt.3) **Enforcement actions: Significant actions resolved, material licensees (non-medical). Quarterly progress report, July–September 1994: Volume 13, Number 3, Part 3.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Enforcement. Dec 1994. 319p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This compilation summarizes significant enforcement actions that have been resolved during one quarterly period (July–September 1994) and includes copies of letters, Notices, and Orders sent by the Nuclear Regulatory Commission to material licensees (non-medical) with respect to these enforcement actions. It is anticipated that the information in this publication will be widely disseminated the managers and employees engaged in activities licensed by the NRC, so that actions can be taken to improve safety by avoiding future violations similar to those described in this publication.

5747 (NUREG–1478) **Non-Power Reactor Operator Licensing Examiner Standards.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Reactor Controls and Human Factors. Jun 1994. 192p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

The Non-Power Reactor Operator Licensing Examiner Standards provide policy and guidance to NRC examiners and establish the procedures and practices for examining and licensing of applicants for NRC operator licenses pursuant to Part 55 of Title 10 of the Code of Federal Regulations (10 CFR Part 55). They are intended to assist NRC examiners and facility licensees to understand the examination process better and to provide for equitable and consistent administration of examinations to all applicants by NRC examiners. These standards are not a substitute for the operator licensing regulations and are subject to revision or other internal operator examination licensing policy changes. As appropriate, this standard will be revised periodically to accommodate comments and reflect new information or experience.

5748 (NUREG/CP–0133-Vol.3, pp. 1-3) **Materials engineering branch activities in 1993.** Serpan, C.Z. Jr. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

The Materials Engineering Branch, Division of Engineering, Office of Nuclear Regulatory Research, has had an exceptionally busy year of work, encompassing the traditional research program, regulatory codes and standards development, and direct technical assistance to NRR. The research work is detailed in the following papers of this volume, and is highlighted in this summary; the regulatory codes and standards work and the direct technical assistance to NRR however, are not described elsewhere and so are included in more detail in this summary.

5749 (NUREG/CP–0136, pp. 21-30) **Presentation on NRC Regulatory Positions and guidelines.** Russell, W.T. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The NRC staff recognizes the potential for enhanced safety and reliability that digital systems bring to the nuclear industry. The staff also recognizes the challenges to safety that are unique to digital systems implementation.

2108 Economics

Refer also to citation(s) 5849

22 NUCLEAR REACTOR TECHNOLOGY

5750 (INIS-XN–506/A) **NEA activities in 1993. 22. Annual Report of the OECD Nuclear Energy Agency.** Nuclear Energy Agency, 75 - Paris (France). 1994. 63p. Order Number DE95610970. Source: OSTI; NTIS (US Sales Only); INIS.

The titles and themes of the ten chapters of this report on NEA activities are: trends in nuclear energy; nuclear development and the fuel cycle (potential contribution of nuclear energy, policy alternatives, maintaining the nuclear option, prospective); reactor safety and regulation (safety research, regulatory approach, safety assessment, accident phenomenology and management, human factors, international standards); radiation protection (revision of the standards, assessment of the protection, international emergency exercises); radioactive waste management (long term safety assessment, in situ evaluation, other radioactive wastes); nuclear science (role, nuclear data, use of supercomputers, actinide transmutation, NEA Data Bank); joint projects (Three Mile Island vessel investigation, Halden reactor project...); legal affairs (liability aspects...); information programme; relations with non-member countries. 28 figs.

5751 (WHC-SD-SNF-PCP–001) **305 Building Cold Test Facility Management Plan.** Whitehurst, R. Westinghouse Hanford Co., Richland, WA (United States). 3 Oct 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003050. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides direction for the conduct of business in Building 305 for cold testing tools and equipment. The Cold Test Facility represents a small portion of the overall building, and as such, the work instructions already implemented in the 305 Building will be utilized. Specific to the Cold Test there are three phases for the tools and equipment as follows: 1. Development and feature tests of sludge/fuel characterization equipment, fuel containerization equipment, and sludge containerization equipment to be used in K-Basin. 2. Functional and acceptance tests of all like equipment to be installed and operated in K-Basin. 3. Training and qualification of K-Basin Operators on equipment to be installed and operated in the Basin.

2201 Theory and Calculation

Refer also to citation(s) 5729, 5911

5752 (INIS-mf–14421, pp. 177-227) **An overview of the current status of resonance theory in reactor physics application.** Hwang, R. (Argonne National Lab., IL (United States). Reactor Analysis Div.). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

The key issue of the resonance treatment in reactor applications is directly associated with the use of the microscopic cross sections in the macroscopic reactor cells with a wide range of composition, temperature and geometric configurations which gives rise to the so called self-shielding effect. It can be regarded as the most complicated problem in neutron physics, which requires the dependence of many physical variables. The current papers presents a rather subjective overview on the two important elements of particular interest are discussed from both historical as well as the state-of-art perspectives: 1) a concise description of the resonance cross sections as a function of energy and temperature and 2) accurate estimation of the corresponding neutron flux where appropriate. For the past decades, there have been significant advances in all areas pertinent to this intriguing subjects. These include the improvements on our better understanding of the basic theories, our capabilities of dealing with extremely complex problems and the quality of resonance data. Three general areas are still limited to infinite-repeated reactor lattices based on the 1-dimensional cell configuration at the resonance level. Further exploration into the feasibility of treating the problems in multi-dimensional geometries will undoubtedly be of some practical interest. Secondly, extensive bench-mark studies to verify our ability to predict the self-shielding effect and its associated Doppler-effect are apparently lacking. One idea place to begin is to utilize the existing results of various transmission and self-indication measurements. Thirdly, the statistical theory for treating the unresolved resonances is also worthy of further exploration. 2 figs., 33 refs.(orig.).

2202 Components and Accessories

Refer also to citation(s) 5435, 5716, 5723, 5724, 5725, 5726, 5878, 5880, 5881, 5882, 5911, 5953, 6619

5753 (ANL/RE/LWR–93-3) **Direct containing heating experiments in Zion Nuclear Power Plant Geometry using prototypic core materials, the U1A and U1B tests.** Binder, J.L.; McUmber, L.M.; Spencer, B.W. Argonne National Lab., IL (United States). Apr 1993. 67p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95003989. Source: OSTI; NTIS; INIS; GPO Dep.

Direct Containment Heating (DCH) experiments have been performed which utilize prototypic core materials. The experiments reported on here are a continuation of the Integral Effects Testing (IET) DCH program. The IET series of tests primarily addressed the effect of scale on DCH phenomena. This was accomplished by completing a series of counterpart tests in 1/40 and 1/10th linear scale DCH facilities at Argonne National Laboratory (ANL) and Sandia National Laboratories (SNL), respectively. The IET experiments modeled the Zion Nuclear Power Plant Geometry. The scale models included representations of the primary system volume, RPV lower head, cavity and instrument tunnel, and the lower containment structures. The experiments were steam driven at nominally 6.2 MPa. Iron-alumina thermite with chromium was used as a core melt simulant in the IET experiments. While the IET experiments at ANL and SNL provided useful data on the effect of scale on DCH phenomena, a significant question concerns the potential experiment distortions introduced by the use of non-prototypic iron/alumina thermite. Therefore, further testing with prototypic materials has been carried out at ANL. A prototypic core melt was produced for the experiments by first mixing powders of uranium, zirconium, iron oxide (Fe_2O_3), and chromium trioxide (CrO_3). When ignited the powders react exothermically to produce a molten mixture. The amounts of each powder were selected to produce the anticipated composition for a core melt following a station blackout: 57.8 mass% UO_2 10.5 mass% ZrO_2 14.3 mass% Fe, 13.7 mass% Zr, and 3.7 mass% Cr. Development tests measured the initial melt temperature to be approximately 2700 K. The total thermal specific energy content of the melt at 2700 K is 1.2 MJ/kg compared to 2.25 MJ/kg for the iron-alumina simulant at its measured initial temperature of 2500 K.

5754 (ANL/RE/LWR–93-6) **Direct containment heating experiments in Zion Nuclear Power Plant Geometry using prototypic core materials, the U2 test.** Binder, J.L.; McUmber, L.M.; Spencer, B.W. Argonne National Lab., IL (United States). May 1993. 62p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95003990. Source: OSTI; NTIS; INIS; GPO Dep.

A third Direct Containment Heating (DCH) experiments has been completed which utilizes prototypic core materials. The reactor material tests are a follow on to the Integral Effects Testing (IET) DCH program. The IET series of tests primarily addressed the effect of scale on DCH phenomena. This was accomplished by completing a series of counterpart tests in 1/40 and 1/10th linear scale DCH facilities at Argonne National Laboratory (ANL) and Sandia National Laboratories (SNL), respectively. The IET experiments modeled the Zion Nuclear Power Plant Geometry. The scale models included representations of the primary system volume, RPV lower head, cavity and instrument tunnel, and the lower containment structures. The experiments were steam driven at nominally 6.2 MPa. Iron-alumina thermite with chromium was used as a core melt simulant in the IET experiments. While the IET experiments at ANL and SNL provided useful data on the effect of scale on DCH

phenomena, a significant question concerns the potential experiment distortions introduced by the use of non-prototypic iron/alumina thermite. Therefore, further testing with prototypic materials has been carried out at ANL. A prototypic core melt was produced for the experiment by first mixing powders of uranium, zirconium, iron oxide (Fe_2O_3), and chromium trioxide (CrO_3). When ignited the powders react exothermically to produce a molten mixture. The amounts of each powder were selected to produce the anticipated composition for a core melt following a station blackout: 57.8 mass% UO_2 10.5 mass% ZrO_2 14.3 mass% Fe, 13.7 mass% Zr, and 3.7 mass% Cr. Development tests measured the initial melt temperature to be in the range of 2600 - 2700 K. The total thermal specific energy content of the melt at 2700 K is 1.2 MJ/kg compared to 2.25 MJ/kg for the iron-alumina simulant at its measured initial temperature of 2500 K.

5755 (HW–23646) **Technical activities report water studies.** Fryar, R.M. Pacific Northwest Lab., Richland, WA (United States). 3 Mar 1952. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95003235. Source: OSTI; NTIS; GPO Dep.

This report details the behavior of water used in nuclear reactors. Detailed studies concerning water quality and water chemistry are reported.

5756 (LA-UR–94-3208) **A flow reactor for the flow supercritical water oxidation of wastes to mitigate the reactor corrosion problem.** Chitanvis, S.M. Los Alamos National Lab., NM (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941128–1: Annual meeting of the American Institute of Chemical Engineers, San Francisco, CA (United States), 13-18 Nov 1994). Order Number DE95000930. Source: OSTI; NTIS; INIS; GPO Dep.

We have designed a flow tube reactor for supercritical water oxidation of wastes that confines the oxidation reaction to the vicinity of the axis of the tube. This prevents high temperatures and reactants as well as reaction products from coming in intimate contact with reactor walls. This implies a lessening of corrosion of the walls of the reactor. We display numerical simulations for a vertical reactor with conservative design parameters that illustrate our concept. We performed our calculations for the destruction of sodium nitrate by ammonium hydroxide in the presence of supercritical water, where the production of sodium hydroxide causes corrosion. We have compared these results with that for a horizontal set-up where the sodium hydroxide created during the reaction ends up on the floor of the tube, implying a higher probability of corrosion.

5757 (NUREG–1482) **Guidelines for inservice testing at nuclear power plants. Draft report for comment.** Campbell, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering. Nov 1993. 182p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

In this report, the staff gives licensees guidelines for developing and implementing programs for the inservice testing of pumps and valves at commercial nuclear power plants. The report includes U.S. Nuclear Regulatory Commission (NRC) guidance and recommendations on inservice testing issues. The staff discusses the regulations, the components to be included in an inservice testing program, and the preparation and content of cold shutdown and refueling outage justifications and requests for relief from the American Society of Mechanical Engineers Code requirements. The staff also gives specific guidance on relief acceptable to the NRC and advises licensees in the use of this information for application at their facilities. The staff discusses the revised standard technical specifications for the inservice testing program requirements and gives guidance on the process a licensee may follow upon finding an instance of noncompliance with the Code.

5758 (NUREG/CP–0137-Vol.1, pp. 3-7) **Vigilance and reason - The keys to continued credibility.** Arlotto, G.A. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

I have entitle my speech "Vigilance and Reason-The Keys to Continued Credibility". A partitioning of the words gives insight into my view of where we are, where we may be going, and that we have control of our fate. "Continued" indicates that I believe, at present, the American Society of Mechanical Engineers (ASME) Codes and Standards process has credibility. "Keys" connotes that we are at a crossroads and something must be done to stay on track. And "Vigilance and Reason" suggest that we can achieve our goal of continued credibility through exercising vigilance and reason. We cannot rest on our laurels. We must take conscious, positive actions to strengthen the credibility of our products; otherwise we will backslide. It is up to us.

5759 (NUREG/CP–0137-Vol.1, pp. 9-13) **An overview of valve and pump testing regulator issues. Status of generic letter 89-10, future for rulemaking-10 CFR 50.55a, application of probabilistic risk assessment to testing requirements, inservice testing, and advanced reactors.** Russell, W.T. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

Since the last American Society of Mechanical Engineers/U.S. Nuclear Regulatory Commission (ASME/USNRC) symposium, the USNRC has observed improvement in the performance of pumps and valves at nuclear power plants. Nevertheless, reports of problems and component failures continue to occur more frequently that the USNRC and plant management would like. Therefore, the nuclear industry and regulators must continue their efforts to improve the performance of pumps and valves in nuclear power plants. The third joint ASME/USNRC symposium presents and opportunity to exchange information, ideas, and suggestions to improve the performance of pumps and valves. Symposium participants include plant personnel involved with the daily operation of pumps and valves, coordinators of pump and valve programs at nuclear plants, individuals who support the ASME Operations and Maintenance Code for testing pumps and valves, and members of the USNRC staff responsible for evaluating licensee activities to ensure the proper performance of these components.

5760 (NUREG/CP–0137-Vol.1, pp. 17-34) **High-energy flow interruption testing of Anchor/Darling Valve Company gate valves.** Wright, D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Anchor/Darling Valve Company (A/DV) has recently developed an improved flex wedge design intended for use in high-energy flow applications. The improved design was incorporated into a 6-in. 900 lb class flex wedge gate valve. Under a similar project, a double disc gate valve was also manufactured for the purpose of evaluating the high-energy flow performance of A/DV's double disc design. Both valves were subjected to rigorous testing at Wyle Laboratories in Huntsville, Alabama. This paper describes the test specimens, valve preparations, test programs, results of the test programs, and the benefits gained as a result of the program.

5761 (NUREG/CP–0137-Vol.1, pp. 35-61) **The stem factor challenge.** Russell, M.J.; Steele, R. Jr.; DeWall, K.G.; Watkins, J.C.; Bramwell, D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. DOE Contract AC07-76ID01570. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

One of the most important challenges that still needs to be met in the effort to understand the operation of motor-operated, rising-stem valves is the ability to determine stem factor throughout the valve's load range. The stem factor represents the conversion of operator torque to stem thrust. Determining the stem factor is important because some motor-operated valves (MOVs) cannot be tested in the plant at design basis conditions. The ability of these valves to perform their design basis function (typically, to operate against specified flow and pressure loads) must be ensured by analytical methods or by extrapolating from the results of tests conducted at lower loads. Because the stem factor tends to vary in response to friction and lubrication phenomena that occur during loading and wedging, analytical methods and extrapolation methods have been difficult to develop and implement. Early investigations into variability in the stem factor tended to look only at the tip of the iceberg; they focused on what was happening at torque switch trip, which usually occurs at full wedging. In most stems, the stem factor is better (lower) in the wedging transient than before wedging, so working with torque switch trip data alone led many early researchers to false conclusions about the relationship between stem factor and load. However, research at the Idaho National Engineering Laboratory (INEL) has taken a closer look at what happens during the running portion of the closing stroke along with the wedging portion. This shift in focus is important, because functional failure of a valve typically consists of a failure to isolate flow, not a failure to achieve full wedging. Thus, the stem factor that must be determined for a valve's design basis closing requirements is the one that corresponds with the running load before wedging.

5762 (NUREG/CP–0137-Vol.1, pp. 63-73) **Predictable or not predictable? The MOV question.** Thibault, C.L.; Matzkiw, J.N.; Anderson, J.W.; Kessler, D.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

Over the past 8 years, the nuclear industry has struggled to understand the dynamic phenomena experienced during motor-operated valve (MOV) operation under differing flow conditions. For some valves and designs, their operational functionality has been found to be predictable; for others, unpredictable. Although much has been accomplished over this period of time, especially on modeling valve dynamics, the unpredictability of many valves and designs still exists. A few valve manufacturers are focusing on improving design and fabrication techniques to enhance product reliability and predictability. However, this approach does not address these issues for installed and inpredictable valves. This paper presents some of the more promising techniques that Wyle Laboratories has explored with potential for transforming unpredictable valves to predictable valves and for retrofitting installed MOVs. These techniques include optimized valve tolerancing, surrogated material evaluation, and enhanced surface treatments.

5763 (NUREG/CP–0137-Vol.1, pp. 75-100) **Allowable stem nut wear and diagnostic monitoring for MOVs.** Swinburne, P. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

After a motor-operated valve (MOV) stem nut failure in 1991 that contributed to a forced plant shutdown, the FitzPatrick Plant staff developed criteria to check for excessive stem nut wear in MOVs. Allowable stem nut wear monitoring uses both direct dimensional measurement and diagnostic test data interpretation. The wear allowance is based on the recommended permitted backlash discussed in the Electric Power Research Institute/Nuclear Maintenance Assistance Center Technical Repair Guideline for the Limitorque SMB-000 Motor Actuator. The diagnostic analysis technique measures the time at zero load and compares this with a precalculated allowable zero force time. Excessive zero force time may be the result of other MOV problems, such as a loose stem nut lock nut or excessive free play in the drive sleeve bearing. Stress levels for new or nominal stem nuts and stem nuts with the full wear allowance were compared. Bending and shear stresses at the thread root increase for the maximum wear condition when compared with a "new" stem nut. These stresses are directly related to the thread root thickness. For typical MOV loading and common stem threading (with two diameters of thread engagement), the thread stresses are well within acceptable limits for ASTM B584-C86300 (formerly B147-863) manganese bronze (typical stem nut material).

5764 (NUREG/CP–0137-Vol.1, pp. 101-142) **Results of the motor-operated valve engineering and testing program.** Black, B.R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Texas Utilities Electric Company (TU Electric) motor-operated valve (MOV) program for implementing the recommendations of Generic Letter 89-10 has typically included the following: refurbishing each actuator, verifying each actuator's as-built configuration, testing each actuator's motor on a dynamometer, testing each actuator's torque spring pack (which is used to control the torque developed), testing each fully refurbished and reassembled actuator on a torque test stand, and testing as many MOVs as practicable both without fluid flow through the valve and with the maximum test conditions reasonably achievable (static and differential pressures (DP) conditions, respectively). Test data are acquired at 1,000 samples per second for stem thrust, stem torque, stem position, actuator compensator spring pack deflection, actuator torque spring pack deflection, motor current, motor voltage, motor three-phase power, valve upstream pressure, and valve downstream pressure, wherever practicable.

5765 (NUREG/CP–0137-Vol.1, pp. 143-158) **Enhancements to the Idaho National Engineering Laboratory motor-operated valve assessment software.** Holbrook, M.R.; Watkins, J.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. DOE Contract AC07-76ID01570. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

In January 1991, the U.S. Nuclear Regulatory Commission (USNRC) commenced Part 1 inspections to review licensee's motor-operated valve (MOV) programs that were developed to address Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance". In support, of this effort, the Isolation Valve Assessment (IVA) software, Version 3.10, was developed by the Idaho National Engineering Laboratory (INEL) to enable rapid in-depth review of MOV sizing and torque switch setting calculations. In 1994, the USNRC commenced Part 2 inspections, which involve a more in-depth review of MOV in situ testing relative to design-basis assumptions. The purpose of this paper is to describe the latest INEL and industry research that has been incorporated into Version 4.00 of the IVA software to support the latest round of inspections. Major improvements include (a) using dynamic and static test results to determine MOV performance parameters and validate design-basis engineering assumptions, (b) determining the stem/stem-nut coefficient of friction using new research-based techniques, (c) adding the ability to evaluate globe valves, and (d) incorporating new methods to account for the effects of high ambient temperature on the output torque of alternating current (ac) motors.

5766 (NUREG/CP–0137-Vol.1, pp. 179-194) **Preliminary assessment of valve IST effectiveness.** Grove, E.; DiBiasio, A.; Carbonaro, J. Nuclear Regulatory Commission, Washington, DC

(United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

A preliminary review of inservice testing effectiveness for Code Class 1,2, and 3 valves at nuclear power plants was performed. These requirements are specified by the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, and the Operations and Maintenance Standard. The Institute of Nuclear Power Operations Nuclear Plant Reliability Data System (NPRDS) database was used to provide failure reports for these components for 1988 to 1992. This time period coincides with the issuance of Generic Letter 89-04, which resulted in a more consistent application of the requirements by the licensees. For this time period, 8,593 valve failures were identified. From the review of the NPRDS database, the primary failure causes and failure modes for motor-operated valves (MOV), air-operated valves (AOV), and check valves (CV) were identified. Solenoid-operated valves were not reviewed in this study. Plant testing programs were effective in identifying approximately 60% of the CV failures, 46% of the AOV failures, and 44% of the MOV failures.

5767 (NUREG/CP–0137-Vol.1, pp. 195-212) **How to determine an IST program component scope.** Hutton, C.; Hutton, S. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

A clear scope statement is vital for successful inservice testing (IST) or inspection (ISI) programs. This paper discusses the need to agree on the mission and objectives for a program before defining the scope of components to be tested or inspected. The paper then points out useful source documents (codes, regulatory guides, NUREGs, and standards) for specifying the components by safety class.

5768 (NUREG/CP–0137-Vol.1, pp. 213) **Performance based testing and maintenance for check valves.** Kanuch, D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

This paper proposes a methodology for optimizing check valve testing and maintenance activities. Generic Letter 89-04, "Guidance on Developing Acceptable Inservice Testing Programs", and the 1989 Edition of the American Society of Mechanical Engineers (ASME) Code specify the current requirements for testing of check valves. Recent advances in technology and the trend toward performance-based approaches to testing and maintenance represent an opportunity to reduce check valve operation and maintenance costs. This paper describes an evaluation methodology that leads to the specification of an optimum set of inservice testing and maintenance activities for a plant check valve population. The process involves analyzing check valve performance based on preestablished performance attributes. Attributes include relative consequence of failure, historical reliability, maintenance frequency, physical degradation, and service fluid. Each check valve is numerically scored based on the valves' performance against the stated attributes. This score is used to justify a reprioritization of check valve work activities such that safety-significant (high-risk), poor performing valves receive a higher degree of maintenance and testing rigor, while good performing check valves receive less. Applying this methodology may allow justifications for alternative testing and maintenance to be developed and substantiated on the basis of valve performance characteristics versus across-the-board implementation of the ASME Code requirements.

5769 (NUREG/CP–0137-Vol.1, pp. 215-294) **The current state of inservice testing programs at U.S. Nuclear Power Plants - a regulatory overview.** Campbell, P.; Colaccino, J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

Information is provided on inservice testing (IST) of pumps and valves at U.S. nuclear power plants to provide consistency in the implementation of regulatory requirements and to enhance communications among utility licensees who may have, like NSSS vendors, similar kinds and numbers of components or comparable IST programs. Documents discussed include the ASME Operation and Maintenance Standards Parts 6 and 10 (covering inservice testing of pumps and valves in light water reactor power plants), the draft NUREG-1482, Guidelines for Inservice Testing at Nuclear Power Plants (including review comments by Nuclear Management and Resource Council), and applicable Licensee Event Reports including summaries of several reports relating to IST.

5770 (NUREG/CP–0137-Vol.1, pp. 295-319) **Solution to valve failures at Braidwood induced by service water cavitation.** Ozol, J.; Schipiour, B.K.; Wix, J.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

Control valves throttle fluid from a high pressure to a lower pressure. On water systems, this throttling process may be accompanied by cavitation, which induces valve noise, vibration, and material damage. Extensive and significant caviation erosion has been experienced the last 10 years in most service water control valve bodies, downstream flanges, and reducers at Braidwood Station. There have been 40 different and distinct cavitation-induced failures in the service water system at Braidwood Station. These failures have created significant costs and continue to be a lingering source of operational maintenance costs to the Commonwealth Edison Company, which is incurring significant financial losses. It should be noted that almost all service water control valves experience some cavitation effects. Cavitation and cavitation damage are complex and elusive phenomena for which no single, simple analytical model exists. The purpose of this paper is to explain features of service water control valve cavitation failures and some of the solutions used by Commonwealth Edison at their six nuclear stations. The paper discusses the following: (1) Braidwood's history of erosion from cavitation; (2) Erosion-corrosion considerations; (3) The Instrument Society of America's valve sizing equations and how they relate to cavitation; (4) Methods to eliminate cavitation; (5) Corrective actions and practical approaches used by Commonwealth Edison to eliminate cavitation.

5771 (NUREG/CP–0137-Vol.1, pp. 323-334) **EPRI MOV performance prediction program.** Hosler, J.F.; Damerell, P.S.; Eidson, M.G.; Estep, N.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

An overview of the EPRI Motor-Operated Valve (MOV) Performance Prediction Program is presented. The objectives of this Program are to better understand the factors affecting the performance of MOVs and to develop and validate methodologies to predict MOV performance. The Program involves valve analytical modeling, separate-effects testing to refine the models, and flow-loop and in-plant MOV testing to provide a basis for model

validation. The ultimate product of the Program is an MOV Performance Prediction Methodology applicable to common gate, globe, and butterfly valves. The methodology predicts thrust and torque requirements at design-basis flow and differential pressure conditions, assesses the potential for gate valve internal damage, and provides test methods to quantify potential for gate valve internal damage, and provides test methods to quantify potential variations in actuator output thrust with loading condition. Key findings and their potential impact on MOV design and engineering application are summarized.

5772 (NUREG/CP–0137-Vol.1, pp. 335-370) **EPRI flow-loop/ in situ test program for motor-operated valves.** Hosler, J.F.; Dorfman, L.S. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Electric Power Research Institute is undertaking a comprehensive research program to develop and validate methods for predicting the performance of common motor-operated gate, global, and butterfly valves. To assess motor-operated valve (MOV) performance characteristics and provide a basis for methods validation, full-scale testing was conducted on 62 MOVs. Tests were performed in four flow-loop facilities and in nine nuclear units. Forty-seven gate, five globe, and 10 butterfly valves were tested under a wide range of flow and differential pressure conditions. The paper describes the test program scope, test configurations, instrumentation and data acquisition, testing approach, and data analysis methods. Key results are summarized.

5773 (NUREG/CP–0137-Vol.1, pp. 371-390) **Gate valve performance prediction.** Harrison, D.H.; Damerell, P.S.; Wang, J.K.; Kalsi, M.S.; Wolfe, K.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Electric Power Research Institute is carrying out a program to improve the performance prediction methods for motor-operated valves. As part of this program, an analytical method to predict the stem thrust required to stroke a gate valve has been developed and has been assessed against data from gate valve tests. The method accounts for the loads applied to the disc by fluid flow and for the detailed mechanical interaction of the stem, disc, guides, and seats. To support development of the method, two separate-effects test programs were carried out. One test program determined friction coefficients for contacts between gate valve parts by using material specimens in controlled environments. The other test program investigated the interaction of the stem, disc, guides, and seat using a special fixture with full-sized gate valve parts. The method has been assessed against flow-loop and in-plant test data. These tests include valve sizes from 3 to 18 in. and cover a considerable range of flow, temperature, and differential pressure. Stem thrust predictions for the method bound measured results. In some cases, the bounding predictions are substantially higher than the stem loads required for valve operation, as a result of the bounding nature of the friction coefficients in the method.

5774 (NUREG/CP–0137-Vol.1, pp. 391-422) **Butterfly valve torque prediction methodology.** Eldiwany, B.H.; Sharma, V.; Kalsi, M.S.; Wolfe, K. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

As part of the Motor-Operated Valve (MOV) Performance Prediction Program, the Electric Power Research Institute has sponsored the development of methodologies for predicting thrust and torque requirements of gate, globe, and butterfly MOVs. This paper presents the methodology that will be used by utilities to calculate the dynamic torque requirements for butterfly valves. The total dynamic torque at any disc position is the sum of the hydrodynamic torque, bearing torque (which is induced by the hydrodynamic force), as well as other small torque components (such as packing torque). The hydrodynamic torque on the valve disc, caused by the fluid flow through the valve, depends on the disc angle, flow velocity, upstream flow disturbances, disc shape, and the disc aspect ratio. The butterfly valve model provides sets of nondimensional flow and torque coefficients that can be used to predict flow rate and hydrodynamic torque throughout the disc stroke and to calculate the required actuation torque and the maximum transmitted torque throughout the opening and closing stroke. The scope of the model includes symmetric and nonsymmetric discs of different shapes and aspects ratios in compressible and incompressible fluid applications under both choked and nonchoked flow conditions. The model features were validated against test data from a comprehensive flowloop and in situ test program. These tests were designed to systematically address the effect of the following parameters on the required torque: valve size, disc shapes and disc aspect ratios, upstream elbow orientation and its proximity, and flow conditions. The applicability of the nondimensional coefficients to valves of different sizes was validated by performing tests on 42-in. valve and a precisely scaled 6-in. model. The butterfly valve model torque predictions were found to bound test data from the flow-loop and in situ testing, as shown in the examples provided in this paper.

5775 (NUREG/CP–0137-Vol.1, pp. 423-438) **Globe valve performance prediction.** Bonner, S.A.; Coward, R.N.; Damerell, P.S.; Wolfe, K.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Electric Power Research Institute is carrying out a program to improve the performance prediction methods for motor-operated valves. As part of this program, a comprehensive globe valve model was developed to calculate valve stem thrust. This model includes packing load, stem rejection load, disc differential pressure (DP) load, disc weight, disc-to-body friction, and stem torque reaction friction. The model recognizes two possible diameters that may be used in calculating the area for the disc DP load - the disc seat diameter or the disc guide diameter. Guidelines have been developed to determine which diameter is appropriate for a specific valve, based on the valve configuration. The model has been assessed against data from five globe valves, ranging in size from 2 to 10 in. The model predictions compared favorably with the test data for incompressible flow. For flashing water blowdown, the data are not predicted by the model, and further work in this area is required.

5776 (NUREG/CP–0137-Vol.1, pp. 439-460) **Effects of dynamic loading of motor-operated valve actuators.** Damerell, P.S.; Daubresse, S.; Wolfe, K.J.; Dogan, T.; Gleeson, J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

Experience has shown that valves with rising, nonrotating stems that are operated using electro-motor driven actuators can be susceptible to changes in output thrust at a constant torque switch setting as a result of changes in stem load time history. This effect is a concern because tests on these types of valves to verify thrust achieved at torque switch trip are often performed in situ under load conditions different from the required performance conditions.

As part of a motor-operated valve research program being carried out by the Electric Power Research Institute, tests of typical electric motor actuators used with nuclear services valves have been performed. The test results show that changes in output thrust with load time history occur o varying degrees on different stem and stem nut combinations. When the effect exists, there is generally an increase in thrust at torque switch trip when load is developed rapidly from low initial loads, compared to when load is developed slowly. The effect is mainly a result of changes in the coefficient of friction at the stem-stem nut interface. The coefficient of friction is temporarily reduced under rapid loading conditions from low initial load, leading to increased thrust. The root cause is hypothesized to be a "squeeze-film" effect, whereby mixed-mode lubrication (hydrodynamic plus boundary) temporarily replaces boundary lubrication. This paper describes the results of tests performed to better understand the phenomenon.

5777 (NUREG/CP–0137-Vol.1, pp. 461-476) **Preliminary assessment of pump IST effectiveness.** DiBiasio, A.; Grove, E.; Carbonaro, J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

A preliminary review of inservice testing (IST) effectiveness for Class 1, 2, and 3 pumps at nuclear power plants was performed. IST requirements are specified by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, and the Operations and Maintenance Standard (OM Part 6). The Institute of Nuclear Power Operations Nuclear Plant Reliability Data System was used to provide failure reports for these components from 1988 to 1992. This time frame coincides with the issuance of Generic Letter 89-04, which resulted in a more consistent application of the requirements by the licensees. For this time, 2,585 pump failures were reported. A review of these failures indicated that the majority (71.6%) resulted from external leakage. These events were excluded from the study because the typically do not affect pump operability and are not detected by the measurement of IST parameters. The remaining 733 events were reviewed to identify the primary failure causes, failure modes, and method of detection. Plant testing programs, consisting of IST, surveillance testing, detected approximately 40% of these occurrences. Others were detected through operational abnormalities, routine and incidental observations, alarms, and while performing maintenance. This paper discusses the results of the study.

5778 (NUREG/CP–0137-Vol.1, pp. 477-484) **Inservice testing of vertical pumps.** Cornman, R.E. Jr.; Schumann, K.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

This paper focuses on the problems that may occur with vertical pumps while inservice tests are conducted in accordance with existing American Society of Mechanical Engineers Code, Section XI, standards. The vertical pump types discussed include single stage, multistage, free surface, and canned mixed flow pumps. Primary emphasis is placed on the hydraulic performance of the pump and the internal and external factors to the pump that impact hydraulic performance. In addition, the paper considers the mechanical design features that can affect the mechanical performance of vertical pumps. The conclusion shows how two recommended changes in the Code standards may increase the quality of the pump's operational readiness assessment during its service life.

5779 (NUREG/CP–0137-Vol.1, pp. 485-492) **Alternative method of inservice hydraulic testing of difficult to test pumps.** Stockton, N.B.; Shangari, S. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The pump test codes require that system resistance be varied until the independent variable (either the pump flow rate or differential pressure) equals its reference value. Variance from this fixed reference value is not specifically allowed. However, the design of many systems makes it impractical to set the independent variable to an exact value. Over a limited range of pump operation about the fixed reference value, linear interpolation between two points of pump operation can be used to accurately determine degradation at the reference value without repeating reference test conditions. This paper presents an overview of possible alternatives for hydraulic testing of pumps and a detailed discussion of the linear interpolation method. The approximation error associated with linear interpolation is analyzed. Methods to quantify and minimize approximation error are presented.

5780 (NUREG/CP–0137-Vol.1, pp. 493-512) **Description of comprehensive pump test change to ASME OM code, subsection ISTB.** Hartley, R.S. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. DOE Contract AC07-76ID01570. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The American Society of Mechanical Engineers (ASME) Operations and Maintenance (OM) Main Committee and Board on Nuclear Codes and Standards (BNCS) recently approved changes to ASME OM Code-1990, Subsection ISTB, Inservice Testing of Pumps in Light-Water Reactor Power Plants. The changes will be included in the 1994 addenda to ISTB. The changes, designated as the comprehensive pump test, incorporate a new, improved philosophy for testing safety-related pumps in nuclear power plants. An important philosophical difference between the "old code" inservice testing (IST) requirements and these changes is that the changes concentrate on less frequent, more meaningful testing while minimizing damaging and uninformative low-flow testing. The comprehensive pump test change establishes a more involved biannual test for all pumps and significantly reduces the rigor of the quarterly test for standby pumps. The increased rigor and cost of the biannual comprehensive tests are offset by the reduced cost of testing and potential damage to the standby pumps, which comprise a large portion of the safety-related pumps at most plants. This paper provides background on the pump testing requirements, discusses potential industry benefits of the change, describes the development of the comprehensive pump test, and gives examples and reasons for many of the specific changes. This paper also describes additional changes to ISTB that will be included in the 1994 addenda that are associated with, but not part of, the comprehensive pump test.

5781 (NUREG/CP–0137-Vol.1, pp. 513-526) **Argo packing friction research update.** VanTassell, D.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

This paper focuses on the issue of valve packing friction and its affect on the operability of motor- and air-operated valves (MOVs and AOVs). At this time, most nuclear power plants are required to perform postmaintenance testing following a packing adjustment or replacement. In many cases, the friction generated by the packing does not impact the operability window of a valve. However, to date there has not been a concerted effort to substantiate this claim. To quantify the effects of packing friction, it has become necessary to develop a formula to predict the friction effects accurately. This formula provides a much more accurate method of

predicting packing friction than previously used factors based strictly on stem diameter. Over the past 5 years, Argo Packing Company has been developing and testing improved graphite packing systems at research facilities, such as AECL Chalk River and Wyle Laboratories. Much of this testing has centered around reducing and predicting friction that is related to packing. In addition, diagnostic testing for Generic Letter 89-10 MOVs and AOVs has created a significant data base. In July 1992 Argo asked several utilities to provide running load data that could be used to quantify packing friction repeatability and predictability. This technical paper provides the basis to predict packing friction, which will improve calculations for thrust requirements for Generic Leter 89-10 and future AOV programs. In addition, having an accurate packing friction formula will improve packing performance when low running loads are identified that would indicate insufficient sealing force.

5782 (NUREG/CP–0137-Vol.1, pp. 527-534) **Valve packing study.** Cepkauskas, M.M.; Garcia, C.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

The Electric Power Research Institute (EPRI) analytical model for valve packing is examined and extended to obtain important packing drag loads necessary in predicting motor-operated valve performance. First, the EPRI model is cast in a nondimensional form, resulting in further insight and analytical simplification of the packing behavior. Nondimensional tables and curves are presented to enhance the computational efficiency. Expansion of the model to include rotating stem and current packing arrangements having multiple regions of different packing material is provided. Pressure loading of packing is examined. An analytical expression for "effective Poisson's ratio" in terms of real Poisson's ratio is presented. Several examples are considered to provide a working knowledge of this methodology.

5783 (NUREG/CP–0137-Vol.1, pp. 535-546) **Packing force data correlations.** Heiman, S.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

One of the issues facing valve maintenance personnel today deals with an appropriate methodology for installing and setting valve packing that will minimize leak rates, yet ensure functionality of the the valve under all anticipated operating conditions. Several variables can affect a valve packing's ability to seal, such as packing bolt torque, stem finish, and lubrication. Stem frictional force can be an excellent overall indicator of some of the underlying conditions that affect the sealing characteristics of the packing and the best parameter to use when adjusting the packing. This paper addresses stem friction forces, analytically derives the equations related to these forces, presents a methodology for measuring these forces on valve stems, and attempts to correlate the data directly to the underlying variables.

5784 (NUREG/CP–0137-Vol.1, pp. 547-561) **Maintenance planning and performance software for valve packing programs at nuclear power stations (ValvePro Version 2.5).** Hutcheson, N.D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (CONF-940774–Vol.1: 3. ASME/NRC symposium on valve and pump testing, Washington, DC (United States), 18-21 Jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Session 1A–Session 2C: Volume 1.* 532p. Source: OSTI; NTIS; INIS; GPO.

ValvePro Version 2.5 for Windows was developed to help power plant maintenance personnel improve maintenance productivity and quality through a simple, attractive software program, which can be installed on personal computer systems in use at many utilities today. This paper explains the functions of this software and how it can be used by a maintenance organization as a foundation for a consistent, effective valve packing program utilizing sound packing principles.

5785 (NUREG/CR–0137-Vol.2, pp. 3-13) **Model testing on inlet chambers of cooling water pumps.** Schubert, F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

This paper discusses a series of tests performed at the Institute of Fluid Flow Machines in Kaiserslautern, Germany. The tests were designed to investigate the effect of replacing one of the steam turbines in a power plant. The new turbine required more cooling water flow through the condensor, which called for new cooling water pumps. The model tests showed that reliable, long-term service would be impossible without modifying the equipment. The test model was built to use Froude's law to investigate the effects of the changes.

5786 (NUREG/CR–0137-Vol.2, pp. 15-24) **Pressurizer safety valves technical requirements, testing, modifications, and experience.** Werres, H.L. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Nuclear power plant technology and operating methods are constantly monitored to ensure that they reflect state-of-the-art knowledge and experience. This results in plant-specific update measures. Several systems, areas, and disciplines are usually involved, even when the scope of these measures is limited; therefore, a broad knowledge base is required, particularly in the case of complex measures. This updating of both technology and operating methods affects both retrofitting and backfitting of the pressurizer system. Central issues in this regard include overall component engineering (including piping and valves), systems engineering, instrumentation and control engineering, and the requisite qualification testing.

5787 (NUREG/CR–0137-Vol.2, pp. 25-44) **Cooperation-the key to solving tough valve problems.** Steele, R. Jr. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); DeWall, K.G.; Watkins, J.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. DOE Contract AC07-76ID01570. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

A group of Idaho National Engineering Laboratory researchers, under the sponsorship of the U.S. Nuclear Regulatory Commission, has participated in a number of multinational research and test programs in both the U.S. and in Europe. These programs focused on motor-operated valves (MOVs) and piping systems subjected to seismic and flow loads and MOVs subjected to flow loads up to an including pipe break flow. This paper reviews these programs and their results, briefly summarizes related work done by others, including Kraftwerk Union in Germany and the Central Electricity Generating Board of the United Kingdom, and in conclusion discusses some of the current research needs. One of the purposes of this paper is to convey an understanding of the extent to which international cooperation has contributed to valve research.

5788 (NUREG/CR–0137-Vol.2, pp. 55-65) **Use of motor-operated valve diagnostic systems in Japan.** Honjin, Masao (Tokyo Electric Power Co. (Japan)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The objectives of this paper are to (a) present an outline of the diagnostic devices and systems for motor-operated valves (MOVs) that were developed in Japan, (b) present diagnostic experience at Tokyo Electric Power Company's plants, (c) present the typical practices employed in the maintenance activities for MOVs in Japanese nuclear power stations, and (d) evaluate the prospect for future use of these diagnostic systems.

5789 (NUREG/CR–0137-Vol.2, pp. 69-75) **Applying reliability centered maintenance analysis principles to inservice testing.** Flude, J.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Federal regulations require nuclear power plants to use inservice test (IST) programs to ensure the operability of safety-related equipment. IST programs are based on American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code requirements. Many of these plants also use Reliability Centered Maintenance (RCM) to optimize system maintenance. ASME Code requirements are hard to change. The process for requesting authority to use an alternate strategy is long and expensive. The difficulties of obtaining this authority make the use of RCM method on safety-related systems not cost effective. An ASME research task force on Risk Based Inservice Testing is investigating changing the Code. The change will allow plants to apply RCM methods to the problem of maintenance strategy selection for safety-related systems. The research task force is working closely with the Codes and Standards sections to develop a process related to the RCM process. Some day plants will be able to use this process to develop more efficient and safer maintenance strategies.

5790 (NUREG/CR–0137-Vol.2, pp. 77-83) **Evaluation of the safety benefits and costs of proposed revisions to inservice testing requirements for pumps and valves.** Houston, W.H.; Maret, D.L. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

This paper describes the results of an evaluation of the potential safety benefits and costs associated with a set of proposed revisions to American Society of Mechanical Engineers (ASME) Code requirements for inservice testing of pumps and valves. In September 1991, the U.S. Nuclear Regulatory Commission (USNRC) requested that the ASME Operations and Maintenance Committee consider the incorporation of revisions to the Code. The revisions would require that inservice pump and valve testing verify all safety functions and be performed at or near design-basis conditions. Probabilistic risk assessment models developed for the USNRC and the failure data used in performing these probabilistic risk assessments were evaluated to estimate the potential reduction in public risk. Pump and valve failures that might be prevented by the proposed testing were identified. Estimated potential reductions in core damage frequency and associated reductions in public risk were calculated. The results of this evaluation indicate that the proposed revisions to the ASME Code requirements for inservice testing would result in minimal safety benefits that would not met the "significant additional protection" standard established in the backfit rule. Safety benefits estimated in this analysis are several orders of magnitude lower than those that would be required for the proposed revisions to be cost effective. An alternate approach that optimizes inservice testing requirements based on the contribution of each pump or valve to the risk of core damage would be a preferred means of enhancing safety.

5791 (NUREG/CR–0137-Vol.2, pp. 85-94) **Innovative application of probabilistic risk assessment techniques to limit operating and maintenance expenses.** Walberg, P.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Utilities that run nuclear power plants are expending significant resources in responding to U.S. Nuclear Regulatory Commission Generic Letter 89-10 for testing motor-operated valves (MOV). Probabilistic risk assessment (PRA) can be used to determine the relative importance of different MOVs to allow management of resources. There is some concern that typical PRA analysis does not adequately address some issues with respect to MOVs, specifically MOV failure rate and common cause failures. This paper addresses several ways in which the PRA models and data can be adjusted to address these concerns.

5792 (NUREG/CR–0137-Vol.2, pp. 103-109) **Ranking of risk significant components for the Davis-Besse Component Cooling Water System.** Seniuk, P.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Utilities that run nuclear power plants are responsible for testing pumps and valves, as specified by the American Society of Mechanical Engineers (ASME) that are required for safe shutdown, mitigating the consequences of an accident, and maintaining the plant in a safe condition. These inservice components are tested according to ASME Codes, either the earlier requirements of the ASME Boiler and Pressure Vessel Code, Section XI, or the more recent requirements of the ASME Operation and Maintenance Code, Section IST. These codes dictate test techniques and frequencies regardless of the component failure rate or significance of failure consequences. A probabilistic risk assessment or probabilistic safety assessment may be used to evaluate the component importance for inservice test (IST) risk ranking, which is a combination of failure rate and failure consequences. Resources for component testing during the normal quarterly verification test or postmaintenance test are expensive. Normal quarterly testing may cause component unavailability. Outage testing may increase outage cost with no real benefit. This paper identifies the importance ranking of risk significant components in the Davis-Besse component cooling water system. Identifying the ranking of these risk significant IST components adds technical insight for developing the appropriate test technique and test frequency.

5793 (NUREG/CR–0137-Vol.2, pp. 119-122) **Applying risk-based methods to inservice testing.** Rahn, F.J.; Baughman, T.; Parkinson, B.; Rowley, C.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Nuclear plants recognize the value of inservice testing (IST) of pumps, valves, and other safety-related components, but often spend large amounts of resources testing components of relatively

little safety impact. Until the emergence of probabilistic risk assessment (PRA) as an accepted procedure, there was no easy method to quantitatively rank the importance of components. This paper addresses the ways that PRA techniques can be applied to IST in a way that focuses that testing on those components most critical to the safety of the plant, while at the same time reduces the amount of resources (and costs) required to have an effective IST program.

5794 (NUREG/CR–0137-Vol.2, pp. 123-126) **Risk-based ranking of IST components at Seabrook Station.** Rau, L.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Utilities that operate nuclear power plants are facing increasing cost-competitive pressures. In an effort to maintain, and in most cases improve, safety margins while reducing budgets, many companies are using probabilistic methods to help allocate resources efficiently. Probabilistic ranking methods and strategies are also receiving increasing acceptance from the U.S. Nuclear Regulatory Commission, The American Society of Mechanical Engineers, and other regulatory, standards, and oversight bodies. Application of probabilistic methods at Seabrook Station indicates that inservice testing (IST) has the potential for significant reductions in resource expenditures without compromising safety margins. This paper describes the preliminary results of a risk-based ranking of IST components at Seabrook Station and offers an overview of the strategy for applying these results to the IST program. The application will include additional ranking and sensitivity evaluations (beyond those described in this paper) to ensure the fidelity of the final conclusion.

5795 (NUREG/CR–0137-Vol.2, pp. 127-137) **Risk-based maintenance method and applications.** Vo, Truong V. (Pacific Northwest Lab., Richland, WA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Effective maintenance programs can play a significant role in minimizing equipment and structural failures. All aspects of maintenance (i.e., scope, method, timing, and acceptance criteria) can significantly affect the likelihood of component failures. For many pressure-boundary components or others that are subjected to various service conditions in the nuclear power, as well as other industries, inservice maintenance requirements are either based upon prior experience and engineering judgement or are nonexistent. At best, some include an implicit consideration of risk (probability of failure times consequence). To guide the development of an effective maintenance program that focuses on critical plant equipment with the right frequencies and techniques, a risk-based method to maintenance planning has been developed. The method uses results of probabilistic risk assessment, related studies, and relevant industry experience to provide guidance for managing the risks associated with system, structure, and component (SSC) failures. This paper provides suggestions that may be considered during the development of maintenance practices/policies intended to focus on the management of risk associated with SSC failures. The benefits of incorporating these suggestions are also discussed.

5796 (NUREG/CR–0137-Vol.2, pp. 139-151) **Safety significance of inadvertent operation of motor-operated valves in nuclear power plants.** Ruger, C.J. (Brookhaven National Lab., Upton, NY (United States)); Higgins, J.C.; Carbonaro, J.F.; Hall, R.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Concerns about the consequences of valve mispositioning were brought to the forefront following an event at Davis Besse in 1985. The concern related to the ability to reposition "position-changeable" motor-operated valves (MOVs) from the control room in the event of their inadvertent operation and was documented in U.S. Nuclear Regulatory Commission (USNRC) Bulletin 85-03 and Generic Letter (GL) 89-10. The mispositioned MOVs may not be able to be returned to their required position due to high differential pressure or high flow conditions across the valves. The inability to reposition such valves may have significantly safety consequences, as in the Davis Besse event. However, full consideration of such mispositioning in safety analyses and in MOV test programs can be labor intensive and expensive. Industry raised concerns that consideration of position-changeable valves under GL 89-10 would not decrease the probability of core damage to an extent that would justify licensee costs. As a response, Brookhaven National Laboratory has conducted separate scoping studies for both boiling water reactors (BWRs) and pressurized water reactors (PWRs) using probabilistic risk assessment (PRA) techniques to determine if such valve mispositioning by itself is significant to safety. The approach used internal events PRA models to survey the order of magnitude of the risk-significance of valve mispositioning by considering the failure of selected position-changeable MOVs. The change in core damage frequency was determined for each valve considered, and the results were presented as a risk increase ratio for each of four assumed MOV failure rates. The risk increase ratios resulting from this failure rate sensitivity study can be used as a basis for a determination of the risk-significance of the MOV mispositioning issues for BWRs and PWRs.

5797 (NUREG/CR–0137-Vol.2, pp. 155-162) **Dynamic testing of POSI-SEAL motor-operated butterfly valves using strain gages.** Richard, M.C.; Chiou, D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Utilities operating nuclear power plants recognize that the correct functioning of all motor-operated valves, and particularly those in safety-related systems, is of paramount importance. The U.S. Nuclear Regulatory Commission has issued Generic Letter 89-10 relative to this concern. Operability must be demonstrated under design-basis conditions. In order to demonstrate operability of motor-operated butterfly valves, the valve stem torque must be determined. The valve stem torque is a function of seat material, stem packing, stem bearing friction, and hydrodynamic lift and drag. The total valve operating hydrodynamic torque can be predicted using the valve manufacturer's data and the differential pressure. In order to validate the valve manufacturer's data, the actual total valve hydrodynamic torque is measured using strain gages mounted directly on the valve stem. This paper presents the results of comparing the predicted total valve operating hydrodynamic torque with the actual total valve operating hydrodynamic torque for six POSI-SEAL Class 150 high performance butterfly valves.

5798 (NUREG/CR–0137-Vol.2, pp. 189-192) **Periodic and postmaintenance testing of motor-operated valves.** Carr, R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Motor-operated valve (MOV) testing programs have been developed and implemented by most utilities during the last 5 years. To

date, most of the emphasis has been on baseline and design-basis testing. Programs for periodic and postmaintenance testing are being developed, but most rely on at-the-valve techniques for ascertaining valve condition. Methods that avoid sending test personnel to the valve condition. Methods that avoid sending test personnel to the valve save time and radiation exposure and may often be the only alternative when plant conditions preclude entry into the area containing the valve. This paper discusses the viability of various techniques used for periodic and postmaintenance testing and the direction that future testing may take.

5799 (NUREG/CR–0137-Vol.2, pp. 193-202) **Efforts by the nuclear industry to evaluate check valve failures.** Hart, K. (Oak Ridge National Lab., TN (United States)); McElhaney, K.L.; Casada, D.A. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Check valves are critical components in the operation of current generation nuclear power plants, and may serve as increasingly critical role in the designs of future advanced light water reactors. Check valve failures can result in significant operating transients, increased costs, and/or decreased system availability. Increasingly, the tools and methodologies which the industry uses to improve performance, monitor deterioration, and indicate improvement are based on component failure data. It is essential that accessible, detailed failure data be made available to ensure that these methodologies are successful. Existing data must be reviewed, filtered, updated, and supplemented in order to provide the tools for susccessful implementation of proposed methodologies. Over the past several years the efforts of the U.S. Nuclear Regulatory Commission, Institute of Nuclear Power Operations, and the nuclear industry have laid a foundation and supplied the building blocks to establish a system to support these efforts. Combined with research efforts ongoing at Oak Ridge National Laboratory, this system could be available in part by the end of 1994, with the objective of providing an easily accessible failure/reliability database for check valves installed in safety-related nuclear applications.

5800 (NUREG/CR–0137-Vol.2, pp. 219-232) **Validation of TVA's generic letter 89-10 MOV design methodology.** Beltz, I.L.; Simmons, R.G. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The Tennessee Valley Authority's (TVA) plan for addressing the issues in the U.S. Nuclear Regulatory Commission's Generic Letter 89-10 includes a calculation methodology to determine the thrust/torque required for gate and globe valves to overcome pressure during opening and closing. The calculation methodology was developed to contain enough conservatism to ensure that the calculated thrust would envelope the actual required thrust. TVA committed to review differential pressure test results against calculated values to verify the equations and factors and to revise the calculation methodology where necessary. This paper will discuss the calculation methodology that TVA uses and presents the process that is used to reconcile test results with calculated values.

5801 (NUREG/CR–0137-Vol.2, pp. 243-252) **Nonintrusive stroke timing and diagnostic testing of solenoid-operated valves.** Carow, J.P. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

In some cases, for solenoid-operated valves (SOVs) that are required to conform to the Section XI, Paragraph IWV-3413(b) of the American Society of Mechanical Engineers Code, power-operated valve stroke timing requirements cannot be stroke timed using conventional methods because of a lack of electrical position indicators. A nonintrusive stroke timing and diagnostic test technique, based on monitoring coil current through inductive principles, was developed for rapid acting, ac-powered, rectified coil SOVs. The technique can accurately measure valve stroke time during plant system operation without intrusion into plant electrical systems. Examples of field test data and laboratory benchtop test data will be discussed for ac-powered, rectified coil, direct-acting and pilot-operated SOVs. Similar methods for testing dc SOVs will also be discussed.

5802 (NUREG/CR–0137-Vol.2, pp. 255-261) **Generic letter 89-10 and resolution of the motor-operated valve issue.** Scarbrough, T.G. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The U.S. Nuclear Regulatory Commission (USNRC) requires that motor-operated valves (MOVs) important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions they must perform. Despite these requirements, operating experience and research revealed problems with the performance of MOVs in operating nuclear power plants. In response to the concerns about MOV performance, the USNRC issued Generic Letter 89-10 (GL 89-10), "Safety-Related Motor-Operated Valve Testing and Surveillance", and its supplements. Many licensees are approaching completion of the aspects of their GL 89-10 programs associated with the review of MOV design bases, initial verification of MOV switch settings, testing of MOVs under design-basis conditions where practicable, and improvement of evaluations of MOV failures and necessary corrective action. Licensees will need to establish processes to ensure that the long-term aspects of their GL 89-10 programs, such as periodic verification of MOV capability and the trending of MOV problems are maintained. Many MOV problems have been revealed at nuclear power plants as a result of the comprehensive programs of MOV testing and analyses developed by nuclear power plant licensees in response to GL 89-10. These MOV problems were corrected by the licensees when identified. The USNRC staff believes that the number of MOV problems and the operating events caused by those problems are being reduced by the response to GL 89-10 and will significantly decrease as licensees complete their GL 89-10 programs.

5803 (NUREG/CR–0137-Vol.2, pp. 263-269) **Motor-operated valve inspection results.** Runyan, M.F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The U.S. Nuclear Regulatory Commission staff conducted inspections of motor-operated valve (MOV) programs in nuclear power plants according to guidance in Temporary Instruction 2515/109, "Inspection Requirements for Generic Letter 89-110, Safety-Related Motor-Operated Valve Testing and Surveillance". This paper discusses specific findings from the plant inspections in the following areas: scope, design-basis review, MOV sizing and switch settings, MOV design-basis verification, periodic verification of design-basis capability, corrective action and trending, and schedule.

5804 (NUREG/CR–0137-Vol.2, pp. 271-273) **Inservice testing regulatory overview.** Campbell, P.L. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United

States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

In 1989, the U.S. Nuclear Regulatory Commission (USNRC) issued Generic Letter 89-04 (GL 89-04), "Guidance on Developing Acceptable Inservice Testing Programs", to address the backlog of staff reviews of relief requests from the inservice testing (IST) requirements. The USNCR asked certain licensees to respond to the generic letter by indicating which relief requests did not comply with the guidance in the positions in Attachment 1 of the generic letter. The USNRC has reviewed the responses and has issued safety evaluations for those that included new or revised relief requests. The USNRC is now able to review licensee submittals within 6 to 9 months. On December 16, 1993, a draft supplement to GL 89-04 was published for comment in the Federal Register (Volume 58, No. 240, pages 65738 and 65739) referencing draft NUREG-1482, Guidelines for Inservice Testing at Nuclear Power Plants. A public meeting was held on February 2 and 3, 1994. The staff received a number of questions related to the content of the NUREG report and requests that the USNRC address additional issues. The comments are being incorporated into the NUREG report as appropriate. All questions are being included in an appendix to the report along with staff responses and suggestions on how to obtain the requested information. Questions that may be more appropriately addressed by the American Society of Mechanical Engineers (ASME) Operations and Maintenance (Q&M) Code committees are being consolidated into a letter from the USNRC to the ASME.

5805 (NUREG/CR–0137-Vol.2, pp. 275-279) **USNRC and industry's activities to improve the performance of check valves.** Grubelich, F.T. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

In response to staff concerns over reported performance and operational readiness of check valves, the U.S. Nuclear Regulatory Commission (USNRC) developed a plan to promote improvements in the performance and operational readiness of check valves. The action plan to organize activities aimed at resolving the concerns about check valve performance and operational readiness is described in the USNRC report, NUREG-1352, "Action Plan for Motor-Operated Valves and Check Valves", issued in June 1990. The implementation and interim progress of the efforts were presented at the July 1992, USNRC/ASME Second Symposium on Pump and Valve Testing. This paper reports on the status of subsequent efforts of the action plan activities, industry activities, staff conclusions, and future plans.

5806 (NUREG/CR–0137-Vol.2, pp. 281-290) **Pressure locking and thermal binding gate valves.** Brown, E.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The nuclear industry has been aware of the potential for valve inoperability caused by pressure locking and thermal binding for many years. Pressure locking or thermal binding is a common-cause failure mechanism that can prevent gate valve opening on demand, and could render redundant trains of safety systems, or multiple safety systems, inoperable. In spite of numerous generic communications issued by the U.S. Nuclear Regulatory Commission (USNRC) and industry, gate valves in nuclear plant safety-related systems continue to experience pressure locking and thermal binding. USNRC investigations of gate valve pressure locking and thermal binding events and surveys of licensee evaluations and corrective measures concerning the locking mechanisms indicate that the valve locking is a result of inadequate design consideration under specific system and plant operating conditions. Most valve binding events occurred during infrequent plant evolutions, system transients, or unusual system alignments. Hence, the inadequate design would not necessarily be discovered during plant startup testing or regular surveillance testing. The USNRC staff described the results of its analysis in NUREG-1275, Volume 9. A subsequent survey has found that (a) most licensees had made multiple attempts to address the issue with limited implementation of industry guidance to prevent or correct the problem, (b) three incorrect assumptions were used that prevent licensees from identifying valves susceptible to pressure locking or thermal binding, (c) low-pressure emergency core cooling system valves (low-pressure coolant injection, low-pressure core spray, residual heat removal, and pressurized water reactor containment sump sunction) appear most susceptible and risk significant, and (d) a programmatic approach involving system, operations, and component personnel is needed in order to identify the potential for valve locking.

5807 (NUREG/CR–0137-Vol.2, pp. 291-298) **Advanced reactor pump and valve issues.** Li, Y.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The U.S. Nuclear Regulatory Commission (USNRC) regulations in Title 10 of the Code of Federal Regulations, Part 50-55a (10 CFR 50.55a) incorporates by reference the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code for criteria to conduct inservice testing (IST) of pumps and valves. In Office of the Secretary of the Commission Paper (SECY) 90-016 (dated January 12, 1990), the staff recommended certain criteria to the USNRC to be used to supplement the ASME Code requirements for IST of safety-related pumps and valves for evolutionary advanced light-water reactor (ALWR) designs. In its staff requirements memorandum of June 26, 1990, the USNRC approved the staff's positions as supplemented in the April 27, 1990, staff response to Advisory Committee on Reactor Safeguards comments. This paper discusses the following pump and valve issues for evolutionary ALWR designs: design and qualification of pumps and valves, preoperational testing of pumps and valves, and issues concerning the IST of pumps and valves as stated in SECY-90-016.

5808 (NUREG/CR–0137-Vol.2, pp. 299) **Guidelines for optimizing safety benefits in ensuring the performance of motor-operated valves.** Callaway, R.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

For the past several years, both the U.S. nuclear power industry and the U.S. Nuclear Regulatory Commission have devoted significant attention and resources toward improving the performance of motor-operated valves (MOVs). Clearly, the level of attention and resources given to MOVs has resulted in an improved understanding of the design, operation, and maintenance of these components. The enhanced knowledge of these types of valves provides the engineering basis for maintaining reliable performance over their service lives. The accumulation of this knowledge, however, has come at a tremendous expense that continues to absorb industry and regulatory attention and resources. Given that the contribution to safety of individual MOVs varies widely, a number of questions have been raised concerning whether this expenditure results in commensurate benefits and to what extent this expenditure should continue. This paper proposes to apply resources in a

manner that is commensurate with the safety-significance of individual MOVs. This approach should not only lead to increased levels of confidence in plant safety, but should also result in a more efficient use of industry and regulatory resources. This paper recommends using a graded approach that can optimize the safety benefits in ensuring MOV performance. The graded approach is founded on a blend of probabilistic and deterministic methods.

5809 (NUREG/CR–0137-Vol.2, pp. 301-306) **Risk-based approach for prioritizing motor-operated valves.** Weidenhamer, G.H.; Vesely, W.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The United States Nuclear Regulatory Commission issued Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance" in June 1989. This regulatory document was issued because of the concern for the performance of motor-operated valves (MOVs) under accident loads. The GL 89-10 requests licensees to develop a plan to ensure that safety-related MOVs will accomplish their functions under design basis loads. It also requests licensees to perform design-basis flow tests on the MOVs to establish actual thrust requirements where practicable. In addition, it is recommended that the MOVs be periodically verified to ensure that they will perform their functions throughout the life of the plant. This paper identifies an approach by which MOVs can be prioritized based on risk importance to fulfill the periodic verification part of GL 89-10. Also, schedule for tests and maintenance of MOVs can be established based on their risk contributions. Those MOVs having the largest impact on plant safety can be grouped and then reverified (tested) and maintained at more frequent intervals. Those MOVs with lower impacts on plant safety can be placed in a second group and reverified and maintained at longer periodic intervals. A third group of safety-related MOVs would contain those that have the lowest impact on plant safety. This last group would be reverified and maintained at even longer intervals. This approach for prioritizing MOVs and establishing groups for scheduling reverification tests and maintenance intervals can be cost effective and can aid in optimizing resources for implementing GL 89-10 for the remaining life of the plant.

5810 (NUREG/CR–0137-Vol.2, pp. 333-336) **Modeling valve leakage.** Bell, S.R.; Rohrscheib, R. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

The American Society of Mechanical Engineers (ASME) Code requires individual valve leakage testing for Category A valves. Although the U.S. Nuclear Regulatory Commission (USNRC) has recognized that it is more appropriate to test containment isolation valves in groups, as allowed by 10 CFR 50, Appendix J, a utility seeking relief from these Code requirements must provide technical justification for the relief and establish a conservative alternate acceptance criteria. In order to provide technical justification for group testing of containment isolation valves, Illinois Power developed a calculation (model) for determining the size of a leakage pathway in a valve disc or seat for a given leakage rate. The model was verified experimentally by machining leakage pathways of known size and then measuring the leakage and comparing this value to the calculated value. For the range of values typical of leakage rate testing, the correlation between the experimental values and calculated values was quote good. Based upon these results, Illinois Power established a conservative acceptance criteria for all valves in the inservice testing (IST) program and was granted relief by the USNRC from the individual leakage testing requirements of the ASME Code. This paper presents the results of Illinois Power's work in the area of valve leakage rate testing.

5811 (NUREG/CR–0137-Vol.2, pp. 347-354) **Onsite nitrogen testing of main steam relief valves.** Hoerman, K.; Puckett, B. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

Set point testing of main steam relief valves is typically performed by service vendors at offsite facilities that can handle contaminated equipment and develop the steam pressures and quantities necessary for this testing. Because of the risk of failures that require testing additional valves, this work sometimes can become a critical path. In order to reduce outage impacts from this testing, Illinois Powder worked with VECTRA Technologies, Inc. (VECTRA, formerly Pacific Nuclear) to develop onsite test capabilities using nitrogen. As a result, all as-found testing was completed with 3 weeks of the outage start (eight valves were tested as a result of a failure in the first sample). However, all testing was completed in the time allotted to ship the valves off and obtain results from the first sample. Additional savings will result from the use of onsite craftsmen to refurbish the valves. This paper presents the results of Illinois Power Company's successful effort to perform onsite nitrogen testing of main steam relief valves. The paper includes discussions of the analytical work necessary to develop the correlations between the use of nitrogen versus steam, the regulatory effort necessary to implement this process, the equipment needed, the economics of onsite testing, and the results from our refueling outage testing during October 1993.

5812 (NUREG/CR–0137-Vol.2, pp. 355-372) **Trending check valve condition via acoustic monitoring during operating flow.** Carow, J.; Allen, J.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. (EGG–2742-Vol.2; CONF-940664–Vol.2: ISFNT-3: 3rd international symposium on fusion nuclear technology, Los Angeles, CA (United States), 27 Jun - 1 jul 1994). In *Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing. Volume 2, Session 3A–Session 4B.* 353p. Source: OSTI; NTIS; GPO; INIS.

A test program has been undertaken to identify trendable acoustic parameters and spectra characteristics, obtained during operating flow conditions, which are capable of indicating check valve degradation. Efforts were made to quantify changes in degradation sensitive acoustic parameters and spectral characteristics for various common types of check valves with artificially induced degradations. Acoustic data were acquired during steady-state operating flow with a single accelerometer and a portable, microprocessor-based, vibration data collector. Acoustic parameters and frequency spectra were calculated by the data collector and transferred to a computer database for analysis and trending. This methodology can be implemented in order to augment conventional, commercially available check valve diagnostic systems that can be difficult to apply on a regular basis, and typically require cycling a valve's state in order to analyze degradation.

5813 (NUREG/CR–6205) **Valve actuator motor degradation.** Kueck, J.D. (Oak Ridge National Lab., TN (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering; Oak Ridge National Lab., TN (United States). Dec 1994. 32p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. (ORNL–6796). Source: OSTI; NTIS; GPO; INIS.

Valve actuator motor degradation and failure has been a significant, but little studied, problem in the nuclear industry. This study provides a discussion of the primary failure mode –thermal degradation– and reviews the basis for the solution to thermal degradation – thermal protection. The study also provides reviews of various industry data bases, discusses effects of other failure modes such as corrosion, and provides a review of other considerations the user should entertain when assessing thermal protection.

2203 Fuel Elements

Refer also to citation(s) 5866

5814 (ANL/RERTR/TM–19, pp. 62) **CERCA is changing its shareholding.** Durand, J.P. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The shareholding of CERCA, previously 50% Framatome and 50% Pechiney is becoming 51% Framatome and 49% Cogema. This new distribution of the shares offers Framatome the position of major French nuclear industry while maintaining its specificity as a manufacturer of nuclear fuel assemblies and special equipments for research reactors, as well as a designer and manufacturer of complex mechanisms for use in large equipments for physics of particles and fundamental research.

5815 (ANL/RERTR/TM–19, pp. 85-91) **A new X-ray inspection of fuel plates.** Poupard, J.F. (CERA, Romans-Sur Isere (France)); Tissier A. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

A new X-ray Inspection Machine based on directly numerized signals has been developed by CERCA. For U-distribution check, this machine presents specific advantages with respect to the previously used equipments. It also allows image processing for further developments.

5816 (ANL/RERTR/TM–19, pp. 92-101) **Characterization of commercially pure aluminum powder for research reactor fuel plates.** Downs, V.D. (Babcock & Wilcox, Lynchburg, VA (United States)); Wiencek, T.C. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Aluminum powder is used as the matrix material in the production of uranium aluminide, oxide, and silicide dispersion fuel plates for research and test reactors. Variability in the characteristics of the aluminum powder, such as moisture content and particle-size distribution, influences blending and compacting of the aluminum/fuel powder. A detailed study was performed to characterize the physical properties of three aluminum powder lots. An angle-of-shear test was devised to characterize the cohesiveness of the aluminum powder. Flow-rate measurements, and scanning electron microscopy were also used in the study. It was found that because of the various types of commercially available powders, proper specification of powder variables will ensure the receipt of consistent raw materials. Improved control of the initial powder will reduce the variability of fuel-plate production and will improve overall plate reproducibility. It is recommended that a standard specification be written for the aluminum powder and silicide fuel.

2204 Control Systems

Refer also to citation(s) 5727, 5749, 5853, 5899, 5900, 5901, 5903, 5904, 5905, 5906, 5909, 5927, 5928, 5929, 5930, 5932, 5933, 5934, 5935, 5936, 5937, 5938, 5939, 5940, 5941, 5942, 5943, 5944, 5945, 5946, 5947, 5948, 5949, 5958

5817 (HW–70711) **Surge suppressors for the PRTR process tube flow meters.** Hesson, G.M.; Thorne, W.L.; Batch, J.M. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 11 Aug 1961. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018226. Source: OSTI; NTIS; GPO Dep.

Each tube of the PRTR is provided with flow monitoring equipment consisting of a venturi flow meter in the inlet piping, sensing lines containing valves, and a Panellit flow transmitter. The flow transmitter does three things: converts the pressure drop signal of the venturi to a visual readout; provides an electrical signal for recording; and provides a signal to the safety circuit which causes a reactor scram should the flow increase or decrease beyond pre-set valves. After startup of the PRTR, it was found that the readings of flow meters on those process tubes which connect near the inlet of the bottom ring headers were fluctuating excessively. As an interim measure during the power tests at low reactor powers, the meter fluctuations were reduced by throttling the valves in the sensing lines from the flow venturi to the flow meter. This was recognized as being questionable for a permanent solution since this practice introduces an unknown and variable lengthening of the response characteristics of the meter. An experimental program was therefore undertaken to determine the degree of valve throttling which might be appropriate for fluctuation suppression and to device other and better methods of suppression. The experiments show that throttling of valves in the flow transmitter sensing lines is not a satisfactory way of decreasing the fluctuations. The valves must be closed to about 1/4 open before they decrease fluctuations significantly. Further closure to about 1/8 open causes an excessive lengthening of the response characteristics of the transmitter. This provides only a very narrow range of valve positions which are permissible and effective. The increased hydraulic flow resistance of 3–5 foot lengths of 1/16-inch tubing in the sensing line causes the flow transmitter system to become nearly critically damped. This will eliminate the oscillatory behavior of the readings without causing an intolerable lengthening of the response of the transmitter.

5818 (JAERI-M–94-068, pp. 76-80) **Applications of error covariance to fast reactor material dosimetry in JOYO.** Chatani, Keiji (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center); Suzuki, Soju. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1994. (CONF-9307182–: Specialists' meeting on covariance data, Tokai (Japan), 15-16 Jul 1993; INDC(JPN)–171/U). In *Proceedings of the specialists' meeting on covariance data.* 95p. Order Number DE94013048. Source: OSTI; NTIS; INIS.

In the JOYO dosimetry neutron spectrum is analyzed by using unfolding code NEUPAC (NEutron Unfolding code PACkage) based on J_1-Unfolding method. Cross section, measured reaction rate, initial guess spectrum and their error covariance are required as input data of NEUPAC. Cross section and its error covariance, which are dominant data, are processed from ENDF/B-V file with error covariance. Neutron spectrum with an uncertainty can be analyzed by using NEUPAC. This error analysis using the error covariance contributes the improvement of reliability for evaluation result such as neutron fluence. Also the present evaluation accuracy on neutron fluence reaches within about 5% for the irradiation test in core region. (author).

5819 (NUREG/CP–0133-Vol.1, pp. 191-206) **On-line calibration monitoring for instrumentation channels in nuclear power plants.** Hashemian, H.M. (Analysis and Measurement Services Corp., Knoxville, TN (United States)); Mitchell, D.W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

This paper presents a review of a research and development (R&D) project being conducted for the US Nuclear Regulatory Commission (NRC) to evaluate the feasibility of on-line monitoring techniques for instrument calibration reduction in nuclear power plants. The project has shown that the calibration drift of most process sensors can be identified on line by monitoring the DC output of the sensors while the plant is at normal operating conditions. This can help identify the sensors that must be calibrated during refueling outages and limit the calibration effort to those sensors that have shown a significant drift.

5820 (NUREG/CP–0133-Vol.1, pp. 207-218) **Issues arising with the application of optical fiber transmission in class 1E systems in nuclear power plants.** Korsah, K. (Oak Ridge National Lab., TN (United States)); Antonescu, C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The application of fiber optic links and networks in safety-critical systems in the next generation of nuclear power plants, as well as in some digital upgrades in present-day plants, will mean that these links must be highly reliable and able to withstand the effect of environmental stressors present at the installation location. This paper discusses the failure modes and age-related mechanisms of fiber optic transmission components and identifies environmental stressors that could adversely affect their reliability over the long term. Some of the standards that could be used in their qualification for safety-critical applications are also discussed briefly.

5821 (NUREG/CP–0136, pp. 47-60) **Industry perspective on digital upgrades: A utility perspective on digital upgrades.** Blauw, R.J. (Commonwealth Edison Company, Chicago, IL (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

Nuclear utilities face the need to upgrade aging and obsolete safety related and other critical equipment. This is the result of operation and maintenance concerns for reliability and maintainability. Digital technology is an option for these upgrades. A number of utilities have attempted exercising the digital option. The regulatory licensing results have been inconsistent and have raised a variety of issues. These issues and the subsequent licensing uncertainties have caused some utilities to temporarily drop digital technology as an upgrade option. Resolution of these issues and the need for regulatory stability is driving the development of industry standards and guidelines. These will provide guidance to support consistent design and implementation of digital upgrades. Successful completion of these documents is necessary for renewed consideration of the use of digital technology. This paper will present a utility perspective on how project management, configuration control, and a rigorous design process can serve to address the present regulatory issues. These issues include commercial grade dedication, reliability, electromagnetic interference, and failure and error management. This perspective is consistent with the standards and guidelines development effort.

5822 (WSRC-MS–94-0359) **Melt behavior of aluminum clad rods.** Geiger, G.T. (Westinghouse Savannah River Co., Aiken, SC (United States)); Long, T.A.; DeWald, A.B. Jr. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950336–1: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE94016540. Source: OSTI; NTIS; GPO Dep.

Since the Li-Al alloy cores in control rods used to control production reactors are susceptible to corrosion by heavy water, they were clad with Al. This paper reports results of an experimental and numerical study of the behavior of control rods heated to the point of clad and rod-core failure. Results show that the core of the rod melts first; the clad fails only after significant additional heating. Once the rod breaks and drops to the bottom of the quartz tube in the furnace, the lower section of the rod fails by "poker-chipping" downward as the topmost portion fails before the portion below it. Part of the core in the remaining top of the rod relocates immediately after rod separation, leaving a hollow tube of Al which also melts upon further heating.

2205 Environmental Aspects

Refer also to citation(s) 5420, 5822, 5876, 5961, 5962, 6561, 6605, 7022

5823 (JAERI-Conf–94-005) **Proceeding of the second steering conference relating to the 'agreement on the Implementation of Research at the Chernobyl Center for International Research' between CHECIR and JAERI.** Nagaoka, Toshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Togawa, Orihiko; Moriuchi, Shigeru; Rybalko, S.I.; Sukhoruchkin, A.K.; Kazakov, S.V. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1994. 105p. (In Japanese, English). (CONF-9402121–: 2. steering conference relating to the 'agreement on the Implementation of Research at the Chrnobyl Center for International Research' beween CHECIR and JAERI, Tokyo (Japan), 22-25 Feb 1994). Order Number DE95737307. Source: OSTI; NTIS; INIS.

On June, 1992, JAERI and CHECIR concluded an agreement on the Implementation of Research at the Chernobyl Center for International Research (CHECIR). Based on the agreement, JAERI started 'Study on Assessment and Analysis of Environmental Radiological Consequences and Verification of an Assessment System.' CHECIR and JAERI make it a rule to hold steering conference twice a year in order to ensure mutual understanding and exchange of opinion because it its indispensable for smooth and effective implementation of this project. The first steering conference in Japan was held in February of 1994, and three research leaders of CHECIR side were invited from Ukraine. At that time, they gave lectures concerning the environmental Headquarter of JAERI. Progress reports on subject-1 and subject-2 were given from JAERI side at the steering conference. The 5 of presented papers are indexed individually. (author).

5824 (KAPL–4793) **Knolls Atomic Power Laboratory annual environmental monitoring report. Calendar Year 1993.** KAPL, Inc., Schenectady, NY (United States). [1993]. 123p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC12-76SN00052. Order Number DE95002195. Source: OSTI; NTIS; INIS; GPO Dep.

The results of the effluent and environmental monitoring programs at the three Knolls Atomic Power Laboratory (KAPL) sites are summarized and assessed in this report. Operations at the three KAPL sites resulted in no significant release of hazardous substances or radioactivity to the environment. The effluent and environmental monitoring programs conducted by KAPL are designed to determine the effectiveness of treatment and control methods, to provide measurement of the concentrations in effluents for comparison with applicable standards, and to assess resultant concentrations in the environment. The monitoring programs include analyses of samples of liquid and gaseous effluents for chemical constituents and radioactivity as well as monitoring of environmental air, water, sediment, and fish. Radiation measurements are also made around the perimeter of each site and at off-site background locations. KAPL environmental controls are subject to applicable state and federal regulations governing use, emission, treatment, storage and/or disposal of solid, liquid and gaseous materials. Some non-radiological water and air emissions are generated and treated on-site prior to discharge to the environment. Liquid effluents and air emissions are controlled and monitored in accordance with permits issued by the Connecticut Department of Environmental Protection (CTDEP) for the Windsor Site and by the New York State Department of Environmental Conservation (NYSDEC) for the Knolls and Kesselring Sites. The liquid effluent monitoring data show that KAPL has maintained a high degree of compliance with permit requirements. Where required, radionuclide air emission sources are authorized by the US Environmental Protection Agency (EPA). The non-radiological air emissions, with the exception of opacity for the boilers, are not required to be monitored.

5825 (NUREG–0837-Vol.14-No.3) **NRC TLD Direct Radiation Monitoring Network. Progress report, July–September 1994: Volume 14, Number 3.** Struckmeyer, R. Nuclear Regulatory Commission, King of Prussia, PA (United States). Region I. Dec 1994. 226p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

The US Nuclear Regulatory Commission (NRC) Direct Radiation Monitoring Network is operated by the NRC in cooperation with participating states to provide continuous measurement of the ambient radiation levels around licensed NRC facilities, primarily power reactors. The Network is intended to measure radiation levels during routine facility operations and to establish background radiation levels used to assess the radiological impact of an unusual condition, such as an accident. This report presents the radiation levels measured around all facilities in the Network for the third quarter of 1994. A complete listing of the site facilities monitored is included. In some instances, two power reactor facilities are monitored by the same set of dosimeters. All radiation measurements are made using small, passive detectors called thermoluminescent dosimeters (TLDs), which provide a quantitative measurement of the radiation levels in the area in which they are placed.

5826 (NUREG/CP–0133-Vol.3, pp. 415-432) **Geologically recent near-surface faulting and folding in Giles County, southwest Virginia: New exposures of extensional and apparent reverse faults in alluvial sediments between Pembroke and Pearisburg.** Law, R.D. (Virginia Tech., Blacksburg, VA (United States)); Pope, M.C.; Wirgart, R.H.; Eriksson, K.A.; Robinson, E.S.; Sayer, S.; Phinney, E.J.; Bollinger, G.A. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. Contract NRC-04-85-121. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

A series of faults have recently been identified which cut a folded succession of stratified alluvial deposits located along the north side of the new River Valley between Pembroke and Pearisburg in Giles County, Virginia. Although the age of neither the faults nor the sediments is currently known, the unlithified nature of the alluvial deposits suggests that both are, geologically, relatively recent (Tertiary or Quaternary). The faults are regarded by the authors as being of considerable potential importance to both the assessment of seismic hazard and to the present understanding of fault development in this section of the Valley and Ridge Province as they would appear to indicate the, at least local occurence, of geologically recent near surface faulting. The occurrence of faulting in these geologically recent sediments was first detected during excavation for land-fill material in early 1992 when two extensional faults were exposed on land owned by Mr Arnold Bostic of Pembroke, Virginia. the authors became aware of these newly exposed faults in late May 1992 and have since carried out a detailed analysis of the near surface folding and faulting of the sediments under Nuclear Regulatory Commission Contract No. NRC-04-85-121. This analysis has involved the excavation of five bench-type exposures (above road level) and one trench (below road level). Reconaissance geophysical surveys have also been undertaken in an attempt to trace to depth the structures revealed in these temporary exposures.

5827 (NUREG/CR–2850-Vol.12) **Dose commitments due to radioactive releases from nuclear power plant sites in 1990: Volume 12.** Baker, D.A. (Pacific Northwest Lab., Richland, WA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Technical Support; Pacific Northwest Lab., Richland, WA (United States). Nov 1994. 185p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC06-76RL01830. (PNL–4221-Vol.12). Source: OSTI; NTIS; GPO; INIS.

Population and individual radiation dose commitments have been estimated from reported radionuclide releases from commercial power reactors operating during 1990. Fifty-year dose commitments for a one-year exposure from both liquid and atmospheric releases were calculated for four population groups (infant, child, teen-ager and adult) residing between 2 and 80 km from each of 72 reactor sites. This report tabulates the results of these calculations, showing the dose commitments for both water and airborne pathways for each age group and organ. Also included for each of the sites is an estimate of individual doses which are compared with 10 CFR Part 50, Appendix 1 design objectives. The total collective dose commitments (from both liquid and airborne pathways) for each site ranged from a high of 15 person-rem to a low of 0.002 person-rem for the sites with plants in operation and producing power during the year. The arithmetic mean was 1.1 person-rem. The total population dose for all sites was estimated at 78 person-rem for the 130 million people considered at risk. The individual dose commitments estimated for all sites were below the Appendix 1 design objectives.

5828 (VTT-TIED–1579) **Radiation risk in Finland due to the nuclear power plant at Sosnovyj Bor.** Ilvonen, M. (VTT Energy, Espoo (Finland)); Rossi, J.; Salonoja, M. Technical Research Centre of Finland, Espoo (Finland). Jun 1994. 94p. (In Finnish). Order Number DE95610979. Source: OSTI; NTIS; INIS.

The present study is an application of the long range transport and dose model TRADOS developed jointly by the Finnish Meteorological Institute and Technical Research Centre of Finland. The aim of the study is to assess the radiation risk in Finland due to the nuclear power plant at Sosnovyj Bor near St. Petersburg in Russia. Probabilities of reaching different parts of the country, transport time and time spent over Finland by the trajectories are presented. Also breadth of the radioactive cloud and incidence of rain are estimated. The calculated radiation doses are based on one single hypothetical release, in which all noble gases are released, together with 10 % of easily vaporizing elements and 1 % of others. All results are based on the assumption that the probability of the release is 100 %. The dose pathways calculated are cloud gamma, fallout gamma, inhalation, and ingestion of milk, meat, green vegetables, grain and roots. External dose rates have been calculated. The necessity of countermeasures and the ratio of the avertable dose to the costs are also assessed. (13 refs., 156 figs., 12 tabs.).

2206 Research, Test, Training, Production, Irradiation, Materials Testing Reactors

Refer also to citation(s) 5091, 5118, 5340, 5747, 5814, 5815, 5816, 5817, 5822, 5876, 5877, 5880, 5886, 5889, 5890, 5902, 6325

5829 (ANL/RERTR/TM–19, pp. 3-13) **The RERTR Program: A status report.** Travelli, A. (Argonne National Lab., IL (United States)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The progress of the Reduced Enrichment Research and Test Reactor (RERTR) Program is described. The major events, findings, and activities of 1991 are reviewed after a brief summary of the results which the RERTR Program had achieved by the end of the 1991 in collaboration with its many international partners. The disappearance of the Soviet Union, the cooperative attitude of the republics which have taken its place, and the end of the Cold War have affected the RERTR program in several ways. The program is now managed by the DOE Office of Arms Control and Nonproliferation, which directs all arms control and nonproliferation activities within DOE, and is part of the ANL Arms Control and Nonproliferation Program, which directs all corresponding activities at Argonne National Laboratory. The program would welcome the opportunity of cooperating with the CIS republics towards the elimination of Russian-origin HEU from international commerce. With renewed interest in nonproliferation, Congress came very close to funding resumption of RERTR fuel development and promised to reconsider the issue. The technical efforts of the RERTR Program were concentrated on technology transfer and implementation activities, consistent with DIE guidance. Existing fuel data were analyzed and

interpreted to derive a better understanding of the behavior of dispersion fuels under irradiation. Computer codes were modifies and upgraded for the analysis of research reactors operating with LEU fuels. Analyses, calculations, and safety evaluations were conducted to support LEU conversions of both US and foreign research reactors. The major current program goal is to work closely with the various reactor and fuel fabrication organizations that are pursuing LEU conversions, so that their objective can be attained at the earliest possible date. International cooperation continues to be essential to the achievement of this goal.

5830 (ANL/RERTR/TM–19, pp. 14-23) **Status of reduced enrichement programs for research reactors in Japan.** Kanda, Keiji (Kyoto Univ., Kumatori-cho, Sennan-gun, Osaka (Japan)); Nishihara, Hideaki; Futamura, Yoshiaki; Shirai, Eiji; Asaoka, Takumi. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The reduced enrichment programs for the JRR-2, JRR-3, JRR-4 and JMTR of Japan Atomic Energy Research Institute (JAERI), and the KUR of Kyoto University Research Reactor Institute (KURRI) have been partially completed and are mostly still in progress under the Joint Study Programs with Argonne National Laboratory (ANL). The JMTR and JRR-2 have been already converted to use MEU aluminide fuels in 1986 and 1987, respectively. The operation of the upgraded JRR-3 was started in March 1990 with the LEU aluminide fuels. The safety review application for two LEU silicide elements in the KUR was approved in May 1991 and the two elements have been inserted to the core in May 1992. The safety review application for the full core conversion to use LEU silicide in the JMTR was approved in February 1992 and the conversion is scheduled in November 1993. The Japanese Government approved a cancellation of the KUHFR Project in February 1991, and the related fuel problem is under discussion.

5831 (ANL/RERTR/TM–19, pp. 24-28) **Status of Canadian low-enriched uranium conversion program.** Schreader, J.W. (AECL Rsearch, Chalk River Labs., Ontario (Canada)); Palleck, S.J.; Sears, d.f.; Brewster, P.M. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The Canadian low-enriched uranium (LEU) conversion program has centered around the conversion of AECL Research's NRU reactor. The Conversion will soon be completed. Over half the reactor core now contains LEU fuel rods. Current reactor loading schedules should see a complete LEU core by the end of 1992 or early in 1993. This is a major accomplishment for the Canadian program and certainly complementary to the RERTR program. The Nuclear Fuel Fabrication Facility, built to house fabrication equipment for new LEU fuel, is now licensed and production is exceeding NRU reactor requirements. Complete results of a test irradiation of Al-U_3Si_2 have been delayed due to a reactor shutdown in 1991.

5832 (ANL/RERTR/TM–19, pp. 31-49) **Optimization of silicide fuel elements.** Ballagny, A. (CEA Saclay, Gif-Sur-Yvette Cedex (France)); Beylot, J.P.; Paillere, J.; Durand, J.P.; Fanjas, Y.; Tissier, A. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The purpose of this paper is to show that it is possible to increase the U-235 loading per fuel element without exceeding the universally qualified maximum uranium density of 4.8 g/cm^3 or modifying the fuel element geometry. The corresponding R & D work includes both safety aspects and industrial production requirements.

5833 (ANL/RERTR/TM–19, pp. 50-62) **Development of higher density fuel at CERCA.** Durand, J.P. (CERCA, Romans-Sur Isere (France)); Fanjas, Y.; Tissier, A. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

CERCA has initiated a fundamental research program for better understanding the behaviour of materials during the fuel plate manufacturing process. Thanks to a major breakthrough and a careful and systematic experimental validation of fabrication parameters, CERCA succeeded to set up an advanced production process adapted to high densities up to 6 g U_T/cm^3. The fabrication test was carried out on full size plates with pure U_3Si_2 in industrial conditions (on 50 plates). Next development steps include checking the stability of obtained results on large scale production and evaluating the cost increase due to the use of advanced process. Furthermore irradiation tests are necessary to qualify the 6 g density in reactor.

5834 (ANL/RERTR/TM–19, pp. 63-75) **Quality assurance and ultrasonic inspection studies in LEU fuel production.** Toft, P. (Riso National Lab., Roskilde (Denmark)); Borring, J.; Adolph, E.; Nilsson, T.M. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

In connection with the efforts to market Low Enriched Uranium Fuel Elements internationally, a Quality Assurance System for the production at Riso National laboratory, Materials Department is described. The department has established a Quality Assurance program to comply with the applicable clauses and elements of the ISO 9002 standard. As a special feature, the development of Ultrasonic Scanning Techniques for detection of blisters and measuring layer thicknesses are described.

5835 (ANL/RERTR/TM–19, pp. 76-84) **Characterization of atomized U_3Si_2 powder for research reactor.** Kim, C.K. (Korea Atomic Energy Research Institute, Daeduk-Danji, Taejon (Korea, Republic of)); Kim, K.H.; Jang, S.J.; Jo, H.D.; Kuk, I.H. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Atomization technique was developed to produce U_3Si_2 powder using rotating disk. It was found that the atomized U_3Si_2 powder has spherical shape and smooth surface. Surface area of atomized powder is smaller by about 30% than that of comminuted powder. Only U_3Si_2 peaks appear on X-ray diffraction of atomized powder and the second phase exists with a small fraction and thin width on microstructure observation. It is also noticed that the atomized U_3Si_2 powder has homogeneous U_3Si_2 phase. Characteristics of atomized U_3Si_2 powder, i.e., spherical shape, smooth surface and homogeneous phase formation, are expected to give improvements in fabrication and to the properties of research reactor fuel.

5836 (ANL/RERTR/TM–19, pp. 105-110) **HEU-LEU conversion of non-power reactors licensed by the Nuclear Regulatory Commission.** Michaels, T.S. (Nuclear Regulatory Commission, Washington, DC (United States)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

This paper reviews the program for conversion of non-power reactors from HEU to LEU fuel in the US. It touches on the regulations which set this conversion in process, the status of conversion efforts at NRC licensed reactors as of 9/92, fuels which have been approved by the NRC, a brief description of the application process for such conversions, a review of the safety analysis reports which

must be completed, and an outline of reactor start-up reports, and comparison with calculations.

5837 (ANL/RERTR/TM–19, pp. 113-118) **Continued conversion of the R2 reactor to LEU fuel.** Jonsson, E.B. (Studsvik Nuclear AB, Nykoping (Sweden)); Hakansson, R. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

A gradual conversion of the R2 reactor in Sweden started in January 1991. This transient conversion, which was optimized to utilize all the HEU fuel, has proceeded according to plans and the change is expected to be completed at the end of 1992. The first LEU elements were loaded in January 1991 and since then 80 LEU elements have been used in 29 difference core layouts. The change to LEU has been quite undramatic as the LEU fuel design was chosen rather conservative. Apart from some power peaking problems in the beginning the conversion has not created any serious problem. The initial large power peaking in fresh LEU bundles adjacent to the high burned HEU control rod followers required some precaution and was solved by a premature loading of LEU control rod followers. Irradiation of seven LEU lead elements started in 1987 and they have now been exposed to high burnups. Weighing has shown that the swelling of the fuel plates is less than 2% even at fission densities of 1.8E21 fissions/cm3.

5838 (ANL/RERTR/TM–19, pp. 119-127) **Status of the University of Virginia reactor LEU conversion.** Rydin, R.A. (Univ. of Virginia, Charlottesville, VA (United States)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The University of Virginia began working on converting the CAVALIER and UVAR reactors to LEU fuel in the Spring of 1986. Early in 1987, based on reactor use considerations, a decision was made to shut down the CAVALIER. A decommissioning plan was submitted to the NRC, and the decommissioning order was issued in early 1992. There is now a tentative agreement to donate the CAVALIER equipment without fuel to the University of North Texas. Design calculations for the UVAR were completed, and the Safety Analysis Report was submitted to the NRC in late 1989. The DOE/EG&G order to manufacture UVAR fuel was placed at B&W in March 1992, and conversion is expected to take place early in 1993.

5839 (ANL/RERTR/TM–19, pp. 128-137) **Completion of the OSURR fuel conversion and power upgrade.** Talnagi, J.W. (Ohio State Univ. Nuclear Reactor Lab., Columbus, OH (United States)); Aldemir, T. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The 10 kW Ohio State University Research Reactor (OSURR) went critical with the standardized 20% enrichment U_3Si_2 - Al fuel elements on 15 December 1988 and has been operating at power levels up to 50 kW since 19 December 1991 with natural convection core cooling. The computational and engineering work related to the conversion/upgrade process is described.

5840 (ANL/RERTR/TM–19, pp. 141-151) **Analytical analyses of startup measurements associated with the first use of LEU fuel in Romania's 14-MW TRIGA reactor.** Bretscher, M.M. (Argonne National Lab., Argonne, IL (United States)); Snelgrove, J.L.; Ciocanescu, M. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The 14-MW TRIGA steady state reactor (SSR) is located in Pitesti, Romania. Beginning with an HEU core (10 wt% U), the reactor first went critical in November 1979 but was shut down ten years later because of insufficient excess reactivity. Last November the Institute for Nuclear Research (INR), which operates the SSR, received from the ANL RERTR program a shipment of 125 LEU pins fabricated by General Atomics and of the same geometry as the original fuel but with an enrichment of 19.7% ^{235}U and a loading of 45 wt% U. Using 100 of these pins, four LEU clusters, each containing a 5 x 5 square array of fuel rods, were assembled. These four LEU clusters replaced the four most highly burned HEU elements in the SSR. The reactor resumed operations last February with a 35-element mixed HEU/LEU core configuration. In preparation for full power operation of the SSR with this mixed HEU/LEU core, a number of measurements were made. These included control rod calibrations, excess reactivity determinations, worths of experiment facilities, reaction rate distributions, and themocouple measurements of fuel temperatures as a function of reactor power. This paper deals with a comparison of some of these measured reactor parameters with corresponding analytical calculations.

5841 (ANL/RERTR/TM–19, pp. 152-164) **Measurements and computations for neutron flux in the Romanian TRIGA steady state reactor HEU core with four experimental LEU fuel clusters.** Whittemore, W. (General Atomics, San Diego, CA (United States)); Snelgrove, J. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The four HEU fuel clusters with the highest ^{235}U burnups were removed from the highly burned 14-MW steady state Romanian TRIGA reactor and replaced with four fresh LEU fuel clusters. The fuel rods in these new clusters contained 45 wt% uranium enriched to about 19.75% ^{235}U with erbium as a burnable poison. A series of measurements was conducted to characterize the neutronic behavior of the new core configuration and to compare with calculated parameters. The neutron flux level and spectrum were measured in an in-core experimental region using the method of activated foils and the SAND II computer code. Additionally, the silver reaction rate distribution was determined using self-powered neutron detectors positioned in a number of fuel rod locations. Separate measurements were made for the gamma rays from the ^{235}U distributed in 15 of the unirradiated fuel rods. The results of careful axial gamma-ray scans of the rods yielded results in agreement with manufacturing records for the ^{235}U distribution. The operational experience for the new core configuration including reactivity values and fuel temperatures will be reported in other papers.

5842 (ANL/RERTR/TM–19, pp. 165-173) **Progress of transient irradiation test with LEU silicide fuel.** Ichikawa, H. (Tokai Research Establishment, Tokai-mura, Naka-gun, Ibaraki-ken (Japan)); Kodaira, T.; Yanagisawa, K.; Fujishiro, T. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Transient irradiation experiments are being progressed in order to study the behavior of low enriched MTR type fuel under transient and/or accidental conditions in the Japan Atomic Energy Research Institute. Up to now, ten experiments have been conducted with fresh silicide fuel mini-plates. The results obtained are summarized as follows: (1) The maximum fuel surface temperatures were 200°C to 970°C with the deposited energy in the fuel mini-plates ranged 62 to 164 cal/g·fuel. The departure from nucleate boiling might occur in every experiments, however, fuel mini-plates remained intact with energy depositions below 82 cal/g·fuel. (2) With energy depositions 94 to 97 cal/g·fuel, the fuel mini-plates were damaged with small intergranular cracks despite low fuel plate surface temperature, below 330°C. It is presumed that they were caused by the thermal stress occured during rapid quenching of the fuel mini-plates. No significant dimensional changes observed in these cases. (3) With energy depositions

above 116 cal/g-fuel, the maximum fuel surface temperatures were beyond 400°C, and the fuel mini-plates were damaged mainly by the melting of the aluminum cladding, accompanying significant dimensional changes. (4) No fuel fragmentation nor mechanical energy generation was observed even in the experiments in which the maximum fuel temperature exceeded 900°C.

5843 (ANL/RERTR/TM–19, pp. 174-185) **A swelling model of LEU silicide fuel for KMRR.** Hwang, Woan (Korea Atomic Energy Research Institute, Daeduk-Danji, Daejeon (Korea, Republic of)); Kim, B.G.; Sim, K.S.; Heo, Y.H.; Suk, Ho Chun. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

A lot of efforts have been made internationally to understand the irradiation behavior and the safety characteristics of uranium silicide fuel. One of the important irradiation performance characteristics of the silicide dispersion fuel element is the diametral increase resulting from fuel swelling. This paper represents an attempt to develop the physical model for the swelling, DFSWELL, by modelling the basic irradiation behavior observed from in-reactor experiments. The most important part of developing the swelling model is the identification of the controlling physical processes. The swelling of the silicide fuel is comprised of the volume change due to three major components; (i) the formation of an interfacial layer between the fuel particle and matrix, (ii) the accumulation of gas bubble nucleation, (iii) the accumulation of solid fission products. In this study, the swelling of the fuel element is quantitatively estimated by considering temperature, fission rate, solid fission product build-up and gas bubble behavior. The DFSWELL model which takes into account the above physical components predicts well the absolute magnitude of silicide fuel swelling in accordance with the power histories in comparison with the experimental data.

5844 (ANL/RERTR/TM–19, pp. 186-196) **A new swelling model and its application to uranium silicide research reactor fuel.** Hofman, G.L. (Argonne National Lab., Argonne, IL (United States)); Rest, J.; Snelgrove, J.L. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

A new version of the dispersion fuel behavior model currently being incorporated in DART, has been generated. The model's description of fuel swelling - more specifically, the evaluation of fission-gas bubble morphology - is significantly improved. Although some of the assumptions underlying the basic model are derived from systems other than U_3Si_2, it represents a physically realistic interpretation of the observed irradiation behavior of U_3Si_2 over a wide range of fission densities and fission rates.

5845 (ANL/RERTR/TM–19, pp. 199-203) **External research reactor fuel cycle: Back-end options.** Gruber, G.J. (NUKEM GmbH, Alzenau (Germany)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The U.S. Department of Energy still has not renewed its Off-Site Fuel Policy for the acceptance of spent foreign Research Reactor Fuels. Two European companies offer reprocessing services under the condition of waste return to the country of origin. Direct disposal of spent RR Fuels is only a very restricted potential national option which has not yet proven its realisation. Other back-end options are not available for the time being.

5846 (ANL/RERTR/TM–19, pp. 204-209) **The re-use of highly enriched uranium (HEU) reprocessed in Europe.** Muller, H. (NUKEM GmbH, Alzenau (Germany)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

After the shut-down of the U.S. reprocessing plants for spent research fuel at Savannah River and Idaho Falls research reactor operators outside the US have been facing the dilemma to close their fuel cycle elsewhere. In Europe the British AEA and the French Cogema have decided to offer reprocessing of spent research reactor fuel in order to close the existing gap. The re-use of reprocessed HEU in Europe strongly depends on the preparedness of European manufacturers of fuel elements for research reactors to accept the reprocessed uranium as base material for their production.

5847 (ANL/RERTR/TM–19, pp. 210-219) **Recycling of reprocessed uranium from research reactors.** Bouchardy, S. (COGEMA, Villacoublay (France)); Pauty, J.F. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Research reactor fuels were already reprocessed in France in the 1970s, and their reprocessing is expected to resume shortly. The uranium recovered still contains a very high enrichment which should be utilized. The recycling of this reprocessed uranium (RepU) in the form of 19.75% U metal is one attractive method proposed by COGEMA. This paper reviews the processes for making uranium metal applied at Pierrelatte, either from UF_6 or from recycle materials. It describes the characteristics of the reprocessed uranium and the way in which COGEMA plans to recycle it in its facilities. Problems of radiation protection are discussed, as well as the research and tests under way, which are intended to confirm the feasibility of this solution.

5848 (ANL/RERTR/TM–19, pp. 220-227) **Intermediate fuel element storage facility at reactor DR 3.** Qvist, J. (Riso National Lab., Roskilde (Denmark)); Nonbol, E. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

In order to cope with delays in the back end of the fuel cycle, a dry vertical storage facility has been constructed at DR 3, a PLUTO type MTR reactor. The capacity of the facility corresponds to ten years of reactor operation. The facility consist of four blocks with 12 storage holes each. Each hole houses the equivalent of 9 fuel elements. Each storage hole is ventilated in order to facilitate monitoring of air humidity and contamination. Special emphasis is placed on the criticality aspect due to the compact design of the facility.

5849 (ANL/RERTR/TM–19, pp. 231-238) **Long term storage/direct disposal V reprocessing - a comparison of the costs for research and test reactor operators.** McColm, C. (UK Atomic Energy Authority, Scotland (United Kingdom)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Solutions to the back-end closure of the research reactor fuel cycle are being sought worldwide since the decision by US DOE to suspend acceptance of spent fuel from abroad in 1988. Reprocessing and subsequent credit/re-use of the recovered uranium has been the traditional method adopted as the solution. However, since operators have now been faced with the real costs of reprocessing, subsequent waste treatment and disposal as opposed to the incentive US DOE price of pre 1988, more cost beneficial alternatives are being sought. One alternative being that of interim storage and possible final disposal in a national repository. This short paper examines the global costs of the traditional and alternative solutions based on AEA's recent experience of interim storage and extensive experience of reprocessing. The assigned monetary values and assumptions used are meant for comparitory purposes and reflect the most recent data available in the UK and

the basic assumption is that the sums involved will be largely representative of the industry worldwide.

5850 (ANL/RERTR/TM–19, pp. 239-250) **Analyses for conversion of the Georgia Tech Research Reactor from HEU to LEU fuel.** Matos, J.E. (Argonne National Lab., Argonne, IL (United States)); Mo, S.C.; Woodruff, W.L. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The 5 MW Georgia Tech Research Reactor (GTRR) is a heterogeneous, heavy water moderated and cooled reactor, fueled with highly-enriched uranium aluminum alloy fuel plates. The GTRR is required to convert to low enrichment (LEU) fuel in accordance with USNRC policy. Results of design and safety analyses performed by the RERTR Program at the Argonne National Laboratory for LEU conversion of the GTRR are summarized. Only those parameters which could change as a result of replacing the fuel are addressed. The performance of the reactor and all safety margins with LEU fuel are expected to be about the same as those with the current HEU fuel.

5851 (ANL/RERTR/TM–19, pp. 251-258) **Safety analysis of the JMTR with LEU fuel.** Komori, Yoshihiro, Sakurai, Fumio (Japan Atomic Energy Research Institute, Oarai Research Establishment, Oarai-machi, Ibaraki-ken (Japan)); Ishitsuka, Etsuo; Sato, Takeshi; Saito, Minoru; Futamura, Yoshiaki. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The license on the use of the LEU silicide fuel for the JMTR (Japan Materials Testing Reactor) was issued in March of 1992, and the core conversion will be carried out in 1993. The safety analysis for the JMTR LEU core was performed in order to examine validity of the safety design principles. Safety criteria for the abnormal conditions were also reviewed. The result suggests that emergency cooling system and safety protection system need to be upgraded for the primary coolant piping failure. Other postulated abnormal conditions were verified to be safely handled with the present safety system.

5852 (ANL/RERTR/TM–19, pp. 277-285) **A comparison of WIMS-D4 and WIMS-D4m generated cross-section data with Monte Carlo.** Woodruff, W.L. (Argonne National Lab., Argonne, IL (United States)); Deen, J.R.; Costescu, C.I. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Cross-section and related data generated by a modified version of the WIMS-D4 code for both plate and rod type research reactor fuel are compared with Monte Carlo data from the VIM code. The modifications include the introduction of a capability for generating broad group microscopic data and to write selected microscopic cross-sections to an ISOTXS file format. The original WIMS-D4 library with H in ZrH, and ^{166}Er and ^{167}Er added gives processed microscopic cross-section data that agree well with VIM ENDF/B-V based data for both plate and TRIGA cells. Additional improvements are in progress including the capability to generate an ENDF/B-V based library.

5853 (ANL/RERTR/TM–19, pp. 289-293) **Core conversion of IAN-R1 reactor.** Ramirez, A.S. (Instituto de Asuntos Nucleares, Santafe de Bogota (Colombia)). Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The IAN-R1 reactors has been operating by the Instituto de Asuntos Nucleares since early 1965. The reactor is used for the production of short lived radioisotopes, radiochemistry, neutron activation analysis and training. The power level is 30 kw. The reactor core consists of 16 HEU plate-type fuel elements, that have been in the core for over 26 years. At 1990 the instrumentation was replaced for a new control system with a microprocessor driven digital control console and data acquisition system. Last year it was installed a new radiation monitoring system and control rod drives with stepping motor drives. The future modifications of the reactor will include the core conversion to LEU and finally the increase of the power between 500 kw and 1 Mw.

5854 (ANL/RERTR/TM–19, pp. 294-300) **Status of the BER II.** Axmann, A. (Hann-Meitner-Institut Berlin GmbH, Berlin (Germany)); Buchholz, H.; Ficher, C.O.; Krohn, H. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The BER II could start the operation with high enriched materials after shut-down period for upgrading procedures. The application for the use of low enriched fuel was submitted to the authority. Whereas all data for a LEU core are evaluated, HEU-LEU mixed fuel elements are still under investigation. A licencing problem occurs with the open back end of the fuel cycle.

5855 (ANL/RERTR/TM–19, pp. 301-309) **Greek research reactor performance characteristics after addition of beryllium reflector and LEU fuel.** Deen, J.R. (Argonne National Lab., Argonne, IL (United States)); Snelgrove, J.L.; Papastergiou, C. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The GRR-1 is a 5-MW pool-type, light-water-moderated and-cooled reactor fueled with MTR-type fuel elements. Recently received Be reflector blocks will soon be added to the core to add additional reactivity until fresh LEU fuel arrives. REBUS-3 xy fuel cycle analyses, using burnup dependent cross sections, were performed to assist in fuel management decisions for the water-and Be-reflected HEU nonequilibrium cores. Cross sections generated by EPRI-CELL have been benchmarked to identical VIM Monte Carlo models. The size to the Be-reflected LEU core has been reduced to 30 elements compared to 35 for the HEU water-reflected core, and an equilibrium cycle calculation has been performed.

5856 (ANL/RERTR/TM–19, pp. 334-344) **Epi-thermal neutron spectra from low and high enrichement uranium fuels at the Georgia Tech Research Reactor for Boron Neutron Capture Therapy.** Klee, K.A. (Neely Nuclear Research Center, Georgia Institute of Technology, Atlanta, GA (United States)); Karam, R.A. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Boron Neutron Capture Therapy (BNCT) is an alternative treatment modality for highly malignant and invasive cancers such as glioblastoma multiforme. Conventional therapies, such as radiation therapy and surgery, are not effective against glioblastoma multiforme because of the multitude of tiny fingerlets protruding from the tumor mass out into healthy brain tissue. The technique of BNCT is dependent on the preferential loading of a B10-enriched compound into the tumor mass. Utilizing the proper beam of epithermal neutrons, the B(n,alpha)Li reaction releases both an alpha particle and a lithium ion, with an average total kinetic energy of 2.33 MeV. These particles have ranges in tissue comparable to the diameter of a cell, approximately 11 microns. The dose will be highly localized to the tumor volume, therefore killing the tumor mass while sparing the surrounding healthy brain tissue. The Georgia Institute of Technology is pursuing the conversion of the Georgia Tech Research Reactor (GTRR) for use in Boron Neutron

Capture Therapy. Within the next two years, GTRR will be converted from HEU to LEU fuel. Epi-thermal beam parameters, for both HEU and LEU fuels, were studied at this time so the conversion can be made with minimal interruption of the project.

5857 (ANL/RERTR/TM–19, pp. 347-356) **Chilean fuel elements fabrication progress report.** Baeza, J. (Comision Chilena de Energia Nuclear, Santiago (Chile)); Contreras, H.; Chavez, J.; Klein, J.; Mansilla, R.; Marin, J.; Medina, R. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Due to HEU-LEU core conversion necessity for the Chilean MTR reactors, the Fuel Elements Plant is being implemented to LEU nuclear fuel elements fabrication. A glove box line for powder-compact processing designed at CCHEN, which supposed to operate under an automatic control system, is at present under initial tests. Results of first natural uranium fuel plates manufacturing runs are shown.

5858 (BNWC–82) **Future river temperatures at 181-N.** Corley, J.P. Pacific Northwest Lab., Richland, WA (United States). 11 May 1965. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94016935. Source: OSTI; NTIS; GPO Dep.

Temperatures of river water entering the N-Reactor secondary cooling system during the past winter have been significantly higher than the inlet water temperatures at K-Area, which in turn are higher than base river temperatures measured at the Priest Rapids gauge station. The obvious source is the heated upstream reactor effluents, magnified by river flow cycling resulting from fluctuations in Priest Rapids power generation. The Reactor Design Analysis Sub-Section, N-Reactor Departmane, General Electric Company, has requested from the Radiation Protection Department answers to two questions: (1) What is the estimated maximum inlet temperature to the N-Area system that could be expected to occur, and (2) What would be the temperature gradient in the river at such time? This document provides calculations, supplementary information, and additional comments.

5859 (BNWL-CC–225-Rev.1) **Final safeguards analysis, high temperature lattice test reactor. Revision 1.** Hanthorn, H.E.; Brown, W.W.; Clark, R.G.; Heineman, R.E.; Humes, R.M. Battelle-Northwest, Richland, WA (United States). Pacific Northwest Lab. Jan 1966. 102p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004420. Source: OSTI; NTIS; GPO Dep.

The PMACS 'reactor-normal' signal signifies that important process variables do not exceed their set points, that various interlocks are properly set, that functional tests of the computer operation are satisfactory, and that the reactor flux level and period derived from two additional, independent, and dissimilar channels are within set limits. This safety circuit combines the features of redundancy, dissimilar components, and frequent testing which are required for best reliability. The experimental equipment auxiliary to the reactor includes two oscillator mechanisms, one to move the test cell or the adjoining cell into and out of position, the other to move small specimens in the test cell or adjoining cells. They have cooling chambers for the removal of specimens from the test cell without the necessity of cooling the reactor. A neutron chopper and time-of-flight spectrometer are provided; the neutron detectors, at the end of a 25-meter flight tube, are in an adjoining small building. Test cores may be assembled on a core dolly have a load capacity of 14,000 lb. Two wire traverse mechanisms are provided for measurements of flux distribution.

5860 (BNWL-SA–1770) **Battelle-Northwest thermal hydraulics laboratory.** Thorne, W.L. Pacific Northwest Lab., Richland, WA (United States). 11 Apr 1968. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95001343. Source: OSTI; NTIS; GPO Dep.

The purpose of this report is to provide a brief written description of the facilities existing at Hanford for research and development in the fields of heat transfer and hydraulics.

5861 (CEA-CONF–11812) **OSIRIS: Twenty seven years of experiments in a multipurpose research reactor.** Joly, C.; Guidez, J.; Contenson, G. de; Marin, J.P. CEA Centre d'Etudes de Saclay, 91 - Gif-sur-Yvette (France). Dept. des Reacteurs Experimentaux. 1993. 21p. (CONF-931174–: Interregional seminar on research reactor centers: future prospects, Budapest (Hungary), 22-26 Nov 1993). Order Number DE95611191. Source: OSTI; NTIS (US Sales Only); INIS.

OSIRIS, one of the french C.E.A. research reactors, is located at SACLAY - PARIS, near research teams and inspection laboratories with considerable technological infrastructure. Since 27 years, the reactor is safely running and is mainly devoted to technological irradiations or examinations and radioisotopes or doped silicon production. To guarantee the safety and the high performances of the reactor, a continuous maintenance and improvement programme has taken place during the whole life of the reactor. This paper - briefly describes the reactor and recalls its main characteristics, summarizes the main points of the 27 years long reactor life, - projects the maintenance programme to the future, - gives an overview of the experimental capabilities. The facility is completed by: - the reactor ISIS, the mock up of OSIRIS, which is employed for testing new core configurations, new fuel elements or irradiation experiments using reactivity effects, neutron flux or gamma ray heating, - two hot-cells with possibility of direct under water transport of activated materials from or to one of the reactors. (authors).

5862 (DPW–55-15-2) **Minutes of Technical Division Steering Committee meeting February 8, 1955, Savannah River Laboratory.** Evans, L.C. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Explosives Dept. 10 Feb 1955. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–936). Order Number DE95004912. Source: OSTI; NTIS; GPO Dep.

A list of studies approved at the meeting is given with programs outlined in the appendix. The following topics were discussed: (1) safety; (2) security violations; (3) arrangements made for interviewees with physics training to visit Building 777; (4) procedures written for handling various fissionable materials on a large scale in the fabrication laboratory; (5) backlog of orders at the Laboratory shop; (6) that the limited number of applications do not justify the use of depleted uranium in the Laboratory; (7) that Savannah River Plant can follow Hanford requirements as to the average and variation of U-235 content in sidestream materials; (8) that Laboratory is to supply the various dimensions and tolerances that probably will be required for tubes with spiral ribs; (9) shipping of various dies and aluminium shapes now being held by aluminium fabricators; (10) obtaining proper hydraulic performance of fuel assemblies; (11) preliminary scopes of work covering process requirements for producing natural uranium elements in plate and tubular form; and (12) arrangements to be made to review the Nuclear Metals Program.

5863 (DPW–55-24-5) **Trip report, Battelle Memorial Institute, March 8–9, 1955.** Herries, R.R. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Atomic Energy Div. 15 Mar 1955. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–800). Order Number DE94018612. Source: OSTI; NTIS; GPO Dep.

W.J. O'Leary and R.R. Herries visited BMI in company with C.C. McBride, SRL, to discuss the results of subcontract research on the extended surface fuel element program and to discuss with BMI personnel the programs included in the recent contract extension. A summary of results are given in the following. Double and triple melts from two 9–10 pound ingots of arc-melted Horizon's thorium showed decreasing porosity. Physical and chemical data, on these as well as on eight previous double melted ingots, are being obtained. The problems involved in obtaining uniform castings of uranium-aluminum alloy for co-extrusion billets were discussed, with emphasis upon those phases to be investigated at BMI. A program was outlined to evaluate the effects of outgassing, by vacuum annealing, on the corrosion resistance of nickel-plated uranium. Data obtained from diffusion studies at BMI show that the mutual diffusion at high temperatures of thorium and aluminum is

slow, with the diffusion of the thorium into the aluminum proceeding somewhat faster than that of the aluminum into the thorium. Possible methods of applying an inner cladding of aluminum to a tubular uranium fuel element were discussed. "Half-dollar" size uranium corrosion samples, nickel-plated and press-clad with 30-mil aluminum at 10 and 15 thousand psi (950 F) are exhibiting better corrosion resistance than did similar samples pressed with 6 thousand psi.

5864 (DPW–56-241) **Visit report, Allegheny Ludlum Steel Corporation on uranium tubes.** Spraggins, N.F. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Atomic Energy Div. 15 May 1956. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–794). Order Number DE94018525. Source: OSTI; NTIS; GPO Dep.

A meeting was held in Wilmington on May 15, 1956, with representatives of Allegheny Ludlum to discuss possible production by Allegheny of uranium tubes in the number needed this next year for development work on tubular elements by Savannah River. Allegheny Ludlum, through king, had expressed a possible interest in the manufacture of uranium tubes. The Allegheny representatives, in the meeting, reiterated their interest in trying to determine whether Allegheny should consider entering the business of fabricating nuclear fuel elements and nuclear fuel element components, pointing out that the did not wish to do this work in existing facilities. Woodhouse covered the work done by Nuclear Metals, Inc., on bare uranium tubes. He stated that this work had reached a stage in which there would be needed, for development purposes, a supply of the order of 500 bare tubes at Savannah River over the next twelve months. These will be in excess of Nuclear Metals ability to supply. King as a director of NMI and Pierce as a former director were familiar with the NMI situation. On question by King, Worthington stated the order-of-magnitude of the tube requirements if the development work is successful and tubes are used on a production basis. It was pointed out, however, that there were uncertainties, quite aside from technical satisfactoriness, as to any production use and that their discussion with Allegheny concerned only the tube supply for development purposes in the next year. Woodhouse outlined briefly the process for manufacture of uranium tubes which is considered best to date. It was stated that there were optional steps and that work was in progress on these, but only the process as covered here was far enough along to consider for use in production of the tubes for development purposes.

5865 (DPW–56-276) **Rough draft of Technical Data Summary covering preparation of initial Mark IIIA plates by extrusion cladding.** O'Leary, W.J.; Herries, R.R. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Atomic Energy Div. 22 Jun 1956. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–793). Order Number DE94018524. Source: OSTI; NTIS; GPO Dep.

This Technical Data Summary comprises the technical information that has been developed to date for the preparation by extrusion cladding of the outer plate of the contemplated Mark IIIA fuel plate bundle. The Mark IIIA fuel bundle is designed to produce plutonium at higher power levels than is possible with the Mark I or Mark VII assemblies. The Mark IIIA and Mark V designs are being developed concurrently for the same purpose. The information, however, on the Mark IIIA design is at present far more complete than for Mark V, and equipment for producing Mark IIIA in test quantities is already available. The purpose of this Technical Data Summary is to have available the facilities for cladding, by an apparently attractive process, a Mark IIIA plate.

5866 (DPW–56-353) **Hazards summary memorandum: Savannah River reactors the production of tritium using tubular fuel elements.** Babcock, D.F.; Menegus, R.L. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Explosives Dept. Sep 1956. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–790). Order Number DE94017912. Source: OSTI; NTIS; GPO Dep.

The Savannah River reactors were operated initially for the production of plutonium, and used slug-type natural uranium fuel elements. Recently one reactor was converted to the production of tritium, and other reactors will be converted soon. slug-type elements (of enriched uranium-aluminum) were charged into this reactor in order to reduce to a minimum the development effort required before the shift to tritium was made. It was recognized, however, that the slug elements would be deficient in that they would give a low yield of tritium per atom of uranium-235 destroyed because of the large parasitic capture of neutrons by aluminum. Also the production rate of tritium would be low because of the small amount of surface available for the transfer of the fission heat. Both of these shortcomings will be reduced materially by the substitution of tubular elements for the slugs now employed. The development of this type of element has progressed so that a full reactor loading of tubular fuel elements is contemplated for early 1957. The special hazards related to the production of tritium using tubular fuel elements are described in this memorandum which has been written as a supplement to a report entitled "Reactor Safety Determination – Savannah River Plant" (DPW-56-106), one section of which described the hazards associated with the production of tritium from slug elements.

5867 (DPW–56-421) **ORNL ceramic information meeting trip report, October 1–3, 1956.** O'Leary, W.J. Du Pont de Nemours (E.I.) and Co., Wilmington, DE (United States). Atomic Energy Div. 25 Oct 1956. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-76SR00001. (SR/H–795). Order Number DE94018521. Source: OSTI; NTIS; GPO Dep.

The meeting was opened by Leo Brewer, who spoke on a "Self-Purifying Reactor." This is a reactor with theoretically designed-in separations processes, involving calculations to show that it is possible to vaporize many fission products away from fuels. The reactor would be analogous to a graphite rod impregnated with a uranium or thorium compound, vapor-coated with zirconium, and cooled by liquid metal. The fission products will vaporize when the rod gets hot enough, and will be carried out of the pile in a flow of helium. The details of what will happen to the rest of the pile at these temperatures, and of the materials of construction required to handle the situation are yet to be worked out. Remarks were heard from representatives of BMI, GE, Lockland, ANL, ORNL, KAPL, AEC and MCW on properties of uranium oxides and other refractory oxides.

5868 (HW–19974) **Calculated and observed P-10 production in H-10.** Ozeroff, W.J. Hanford Works, Richland, WA (United States). 12 Jan 1951. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018600. Source: OSTI; NTIS; GPO Dep.

Recently three H-10 tubes (2,772, 2,176, 3,673) have been removed and the tritium and other gases have been extracted from the Z slugs. It is of interest to compare the calculated volumes of gases with the amounts obtained in these extractions. The comparison is given in this paper. The reasons for the large disagreement are not known at present. As pointed out below, the weakest part of the calculation is the knowledge of the exposure which these Z slugs have received. It is possible that some losses, particularly of tritium, occur during exposure and extraction. In view of these uncertainties, it does not appear likely that more 25 has been burnt up per unit of tritium than has been previously estimated.

5869 (HW–76115) **Calculations of the surface heat flux and fuel temperatures for PRTR MK-I PuO_2-UO_2 fuel element with segregated PuO_2.** Zaloudek, F.R.; Hesson, G.M. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 2 Jan 1963. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018251. Source: OSTI; NTIS; GPO Dep.

The methods used to fabricate the present loading of PuO_2-UO_2 fuel elements for the Plutonium Recycle Test Reactor have resulted in alternating bands of high and low PuO_2 concentration along each rod of the 19-rod elements. These bands are repeated every 1/2 or 1 inch along the length of the rod, depending on whether the loading of the oxides was done in 160 or 80 increments. This nonuniform distribution of PuO_2 results in alternate regions of high and low heat generation rates with a direct influence on surface heat flux and fuel temperatures. Calculations were performed to determine the local surface heat fluxes and fuel temperatures in a rod of a PRTR 19-rod cluster PuO_2-UO_2 fuel element. The results indicated that peak to average flux ratios of 2.37 could occur for fuel rods loaded in 80 increments (1 inch total band length) if no mixing

of the PuO_2-bearing powder occurs with the UO_2 powder. This would result in maximum heat flux of 660,000 Btu/hr-sq ft for a fuel element operating at a tube power of 1,200 KW. For a rod loaded in 160 increments (1/2 inch total band length), the peak heat flux ratio was calculated to be 1.35 (475,000 Btu/hr-sq ft for a 1,200 KW fuel element). These heat flux ratios as well as fuel temperatures are shown in Figures 1 through 4 for two different values of maximum PuO_2 concentration.

5870 (HW–78883) **Hydraulic tests of spline insert modifications: K reactor.** Waters, E.D. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 10 Sep 1963. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94016402. Source: OSTI; NTIS; GPO Dep.

Short communication. HANFORD PRODUCTION REACTORS; TUBES/modifications; NUCLEAR POISONS; TUBES; MODIFICATIONS; HYDRAULICS; FLOW RATE; TESTING; NOZZLES

5871 (SAND–94-0761C) **Thermomechanical analysis of fast-burst reactors.** Miller, J.D. Sandia National Labs., Albuquerque, NM (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941141–3: Physics, safety and applications of pulse reactors, Washington, DC (United States), 13-17 Nov 1994). Order Number DE94016563. Source: OSTI; NTIS; INIS; GPO Dep.

Fast-burst reactors are designed to provide intense, short-duration pulses of neutrons. The fission reaction also produces extreme time-dependent heating of the nuclear fuel. An existing transient-dynamic finite element code was modified specifically to compute the time-dependent stresses and displacements due to thermal shock loads of reactors. Thermomechanical analysis was then applied to determine structural feasibility of various concepts for an EDNA-type reactor and to optimize the mechanical design of the new SPR III-M reactor.

5872 (WHC-SD-FF-ER–099) **Interim storage of sodium in ferritic steel tanks at ambient temperature.** Blackburn, L.D. Westinghouse Hanford Co., Richland, WA (United States). 30 Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001536. Source: OSTI; NTIS; INIS; GPO Dep.

Sodium tanks originally fabricated for elevated temperature service in the Clinch River Breeder Reactor Plant (CRBRP) will be used to store sodium removed from the Fast Flux Test Facility (FFTF) in the Sodium Storage Facility (SSF) at ambient temperature. This report presents an engineering review to confirm that protection against brittle fracture of the ferritic steel tanks is adequate for the intended service.

5873 (WHC-SD-FF-SSP–004-Rev.1) **Fast flux test facility, transition project plan.** Guttenberg, S. Westinghouse Hanford Co., Richland, WA (United States). 15 Nov 1994. 277p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003860. Source: OSTI; NTIS; INIS; GPO Dep.

The FFTF Transition Project Plan, Revision 1, provides changes and project baseline for the deactivation activities necessary to transition the FFTF to a radiologically and industrially safe shutdown condition.

5874 (WHC-SD-PRP-HA–015) **Fast flux test facility hazards assessment.** Sutton, L.N. Westinghouse Hanford Co., Richland, WA (United States). 24 Oct 1994. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004107. Source: OSTI; NTIS; INIS; GPO Dep.

This document establishes the technical basis in support of Emergency Planning Activities for the Fast Flux Test Facility on the Hanford Site. The document represents an acceptable interpretation of the implementing guidance document for DOE Order 5500.3A. Through this document, the technical basis for the development of facility specific Emergency Action Levels and the Emergency Planning Zone is demonstrated.

5875 (WHC-SD-WM-ATP–117) **New supply for canyon fire foam system.** Gainey, T. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004429. Source: OSTI; NTIS; INIS; GPO Dep.

The raw water supply for the B-Plant Canyon fire foam system is being replaced. The 4 inche water supply line to the foam system is being rerouted from the 6 inches raw water line in the Pipe Gallery to the 10 inches raw water main in the Operating Gallery. This document states the acceptance criteria for the flushing and testing to be performed by the contractor.

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Refer also to citation(s) 5420, 5435, 5699, 5702, 5703, 5705, 5706, 5707, 5708, 5710, 5712, 5713, 5714, 5715, 5722, 5728, 5736, 5738, 5746, 5749, 5753, 5754, 5758, 5759, 5760, 5763, 5791, 5792, 5794, 5795, 5796, 5799, 5800, 5802, 5807, 5808, 5809, 5821, 5836, 5838, 5850, 5851, 5859, 6619, 6631, 7074

5876 (ANL/RERTR/TM–19, pp. 259-266) **Dose analysis in safety and site evaluation for the JMTR core conversion of LEU fuel.** Tsuchida, Noboru (Japan Atomic Energy Research Institute, Oarai Research Establishment, Oarai-machi, Ibaraki-ken (Japan)); Shiraishi, Tadao; Takahashi, Yutaka; Inada, Seiji; Kitano, Kyoshiro; Saito, Minoru; Futamura, Yoshiaki. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

Dose analyses in the safety evaluation and the site evaluation were performed for the Japan Materials Testing Reactor (JMTR) core conversion from Medium Enrichment Uranium (MEU) fuel to Low Enrichment Uranium (LEU) fuel. In the safety evaluation, the effective dose equivalents for the public surrounding the site were estimated in the design basis accidents with release of radioactive fission products to the environment. In the site evaluation, maximum exposure doses to the public were estimated in major accident and hypothetical accident. It was confirmed that risk of radiation exposure of the public is negligible and the siting is appropriate for the LEU core as for the present MEU core.

5877 (ANL/RERTR/TM–19, pp. 267-276) **Early detection of coolant boiling in research reactors with MTR-type fuel.** Kozma, R. (Netherlands Energy Research Foundationb, Business Unit Nuclear Energy, Petten (Netherlands)); Turkcan, E.; Verhoef, J.P. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

In this paper, a reactor core monitoring system having the function of early detection of boiling in the coolant channels of research reactors with MTR-type fuel is introduced. The system is based on the on-line analysis of signals of various ex-core and in-core neutron detectors. Early detection of coolant boiling cannot be accomplished by the evaluation of the DC components of these detectors in a number of practically important cases of boiling anomaly. It is shown that noise component of the available neutron detector signals can be used for the detection of boiling in these cases. Experiments have been carried out at a boiling setup in the research reactor HOR of the Interfaculty Reactor Institute, Technical University Delft, The Netherlands.

5878 (BNL-NUREG–60983) **Shear wall experiments and design in Japan.** Park, Y.J.; Hofmayer, C. Brookhaven National Lab., Upton, NY (United States). [1994]. 16p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-941227–3: 5. symposium on current issues related to nuclear power plant structure, equipment and piping, Orlando, FL (United States), 14-16 Dec 1994). Order Number DE95003957. Source: OSTI; NTIS; INIS; GPO Dep.

This paper summarizes the results of recent survey studies on the available experimental data bases and design codes/standards

for reinforced concrete (RC) shear wall structures in Japan. Information related to the seismic design of RC reactor buildings and containment structures was emphasized in the survey. The seismic requirements for concrete structures, particularly those related to shear strength design, are outlined. Detailed descriptions are presented on the development of Japanese shear wall equations, design requirements for containment structures, and ductility requirements.

5879 (CIEMAT–757) **CIEMAT contribution to the international standard problem ISP-34: contain analysis of FAL-ISP 1 test.** Herranz, L.E.; Polo, J. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 58p. Order Number DE95730389. Source: OSTI; NTIS; INIS.

CIEMAT, along with a great number of international laboratories, has participated in the open exercise of the first International Standard Problem addressing fission product transport issues. The FAL-ISP 1, aimed to study particle agglomeration, has been simulated with CONTAIN code. The thermalhydraulic results obtained have been satisfactory and aerosols ones have been reasonably accurate. However, some discrepancies appeared between predictions and experimental data; these are essentially related to the injection phase of the experiment, where the major influence of input approximations took place. In addition, the rationalization of discrepancies pointed potential data inconsistencies. Some parametric studies showed the results sensitivity to input assumptions concerning aerosol characterization and default values in CONTAIN; in general, they confirmed the suitability of most of the approximations taken. (Author)

5880 (CONF-941011–4) **Modeling and analysis of hydrogen detonation events in the Advanced Neutron Source reactor containment.** Taleyarkhan, R.P. (Oak Ridge National Lab., TN (United States)); Georgevich, V.; Kim, S.H.; Valenti, S.N.; Simpson, D.B.; Sawruk, W. Oak Ridge National Lab., TN (United States). Jul 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 3. international conference on containment design and operation; Toronto (Canada); 19-21 Oct 1994. Order Number DE94019321. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes salient aspects of the modeling, analyses, and evaluations for hydrogen detonation in selected regions of the Advanced Neutron Source (ANS) containment during hypothetical severe accident conditions. Shock wave generation and transport modeling and analyses were conducted for two stratified configurations in the dome region of the high bay. Principal tools utilized for these purposes were the CTH and CET89 computer codes. Dynamic pressure loading functions were generated for key locations and used for evaluating structural response behavior for which a finite-element model was developed using the ANSYS code. For the range of conditions analyzed in the two critical dome regions, it was revealed that the ANS containment would be able to withstand detonation loads without failure.

5881 (DOE/NE/37957–T1) **Automatic monitoring of valve status.** Prinz, F.B.; Chern, J.H. Carnegie-Mellon Univ., Pittsburgh, PA (United States). Dept. of Mechanical Engineering. Jun 1989. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-86NE37957. Order Number DE95003598. Source: OSTI; NTIS; GPO Dep.

Authors propose establishing the relationship between valve leaking and thermal gradient to allow detection of valve leakage by observing the piping system's temperature profile and using an expert system to infer the valve condition. They describe their work toward this and their January 1988 report thereon. The authors also suggest designing modern power plants to accommodate a remotely controlled or autonomous vehicle which would carry a device for thermal-gradient leak detection to examine valves in situ.

5882 (DOE/NE/37957–T2) **Automatic monitoring of valve status.** Prinz, F.B.; Chern, J.H. Carnegie-Mellon Univ., Pittsburgh, PA (United States). Dept. of Mechanical Engineering. Jan 1988. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-86NE37957. Order Number DE95004261. Source: OSTI; NTIS; GPO Dep.

Authors note that acoustic emissions from valves and adjacent pipe, used to investigate the problem of valve leakage in power plants, cannot be separated so as to distinguish leakage processes from other causes of ultrasound emissions. They propose establishing the relationship between valve leaking and thermal gradient to allow detection of valve leakage by observing the piping system's temperature profile. Authors note that their mathematical and experimental models of a typical power-plant piping section were found inconsistent, report known and suspected reasons for this, and suggest specific further studies to supply missing data. They also suggest designing modern power plants to accommodate a remotely controlled or autonomous vehicle which would carry a device for thermal-gradient leak detection to examine valves in situ.

5883 (GRS–95) **Safety analysis of BWR-type reactors. Summarizing report.** Kersting, E. (ed.); Linden, J. von (ed.); Mueller-Ecker, D. (ed.); Werner, W. (ed.). Gesellschaft fuer Anlagen- und Reaktorsicherheit (GRS) mbH, Koeln (Gemany). Nov 1992. 119p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT RS 0794. Order Number DE95726933. Source: OSTI; NTIS (US Sales Only); INIS.

As reference plants the two units of the Grundremmingen NPP (KRB-B and KRB-C) were used, both of them BWR-KWU type reactors, series 72. In the course of the safety analysis, representative, safety-relevant events were studied which may lead to reactor core damages. The result of the analyses was that for accidents not controllable by operational and safety systems (danger states) an occurrence frequency of about 5.10^{-5}/a is to be expected, that means the probability is of 1 to 20 000 per plant and year. This occurrence frequency does not take into account an additional afterheat removal and feed system under construction. Already in the course of the analyses, essential improvements of the plant technology and processes for controlling accidents were initiated. Part of them has been implemented in the plant and led to an increased plant safety. Due to the already implemented and envisaged system modifications, an overall high safety level will be achieved. The investigations performed supply concrete hints also for the assessment of other boiling water reactors. In addition, these analyses indentified problems which require further investigation and development. (orig./HP)

5884 (GRS-F–2/1993) **Reports on research programs in the field of reactor safety sponsored by the Federal Minister of Research and Technology. Reported period: July 1 to December 31, 1993.** Gesellschaft fuer Anlagen- und Reaktorsicherheit (GRS) mbH, Koeln (Gemany). 1993. 387p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Order Number DE95725644. Source: OSTI; NTIS (US Sales Only); INIS.

Each progress report represents a compilation of individual reports about objectives, the work performed, the results, the next steps of the work etc. The individual reports are prepared in a standard form by the contractors themselves as a documentation of their progress in work and published by the Forschungsbetreuung at the GRS, (FB) (Research Coordination Department), within the framework of general informations of progress in reactor safety research. The individual reports are classified according to the research program of the safety of LWR 1977-1980 of the BMFT. Another table of uses the same classification system as applied in the nuclear safety index of the CEC (Commision of the European Communities) and the OECD (Organization for Economic Cooperation and Development). The reports are arranged in sequence of their project numbers. (orig.)

5885 (GRS-F-BL–1+2/1994) **List of reports in the field of reactor safety research from BMFT, CEA, EPRI, JSTA and US-NRC. Reported period: January 1 to June 30, 1994.** Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany). 1994. 28p. (In German). Order Number DE95725641. Source: OSTI; NTIS (US Sales Only); INIS.

This list reviews reports from the Federal Republic of Germany, from France, from Japan and from the United States of America concerning single problems in the field of Reactor Safety Research. According to the cooperation of the Bundesministerium fuer Forschung und Technologie (BMFT) with the Commissariat a

l'Energie Atomique (CEA), the Japan Science and Technologie Agency (ISTA), the Electric Power Research Institute (EPRI) and the United States Nuclear Regulatory Commission, these reports are available in the Gesellschaft fuer Anlagen- und Reaktorsicherheit (GRS). The list pursues the following order: Country of origin, problem area concerned, according to the Reactor Safety Research Program of the BMFT, reporting organization. (orig./HP)

5886 (HW–84104) **Transient thermal-hydraulic experiments: N-Reactor inlet connector break.** Rowe, D.S.; Anderson, J.K.; Thorne, W.L. General Electric Co., Richland, WA (United States). Hanford Atomic Products Operation. 14 Sep 1964. 47p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018252. Source: OSTI; NTIS; GPO Dep.

An N-Reactor inlet connector piping break was investigated in a laboratory study to determine the effect of this break on the affected process tube's thermal-hydraulic performance. A full-scale mock-up of the piping between the inlet and outlet risers was used which included actual reactor valves and fittings. An electrically heated half-length section which was equivalent to the downstream half of the reactor fuel column was used to model the heat-generating portion. The simulation of the connector break at the inlet riser was made possible by actuation of high-speed valves. Six runs were made for these tests. Two runs were at 350 psi with initial flow rates of 47,000 lb/hr and test section powers of zero and 1,250 kw. Four runs were made at 1,400 psi with initial flow rates of 85,000 lb/hr and test section powers of zero and 2,500 kw. During two of these runs at 1,400 psi, the butterfly valve was closed to its stop during the flow reversal with scram delays of 1.5 and 5.0 seconds between the time of the "connector break" and the start of power reduction. Experimental results are given.

5887 (IKE–2-108) **Coupling of aerosol behaviour and thermal-hydraulics. Reinforced concerted action on reactor safety source term project.** Bieder, U. (Stuttgart Univ. (Germany). Inst. fuer Kernenergetik und Energiesysteme); De Rosa, F.; Fynbo, P.; Jokiniemi, J.; Paller, A.; Schatz, A. Stuttgart Univ. (Germany). Inst. fuer Kernenergetik und Energiesysteme. Dec 1993. 129p. Contract FI3S-CT92-0006. Order Number DE95733182. Source: OSTI; NTIS (US Sales Only); INIS.

The status of the experimental work (LACE, KAEUER, FALCON test facilities, DEMONA and VANAM experiments) and the new generation of computer codes (eg. CONTAIN, FIPLOC-M, ITHACA, GOTHIC-M) for a coupled calculation of thermohydraulic and aerosol processes is reviewed and the lack of the present state of knowledge is summarized. The role of the coupled calculations with respect to advanced reactor design and to operating LWRs is also considered. (HP)

5888 (LA-UR–94-2751) **A GASFLOW analysis of a steam explosion accident in a typical light-water reactor confinement building.** Travis, J.R. (ESSI Inc. (United States)); Wilson, T.L.; Spore, J.W.; Lam, K.L.; Rao, D.V. Los Alamos National Lab., NM (United States). [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941011–2: 3. international conference on containment design and operation, Toronto (Canada), 19-21 Oct 1994). Order Number DE94018258. Source: OSTI; NTIS; INIS; GPO Dep.

Steam over-pressurization resulting from ex-vessel steam explosion (fuel-coolant interaction) may pose a serious challenge to the integrity of a typical light-water reactor confinement building. If the steam generation rate exceeds the removal capacity of the Airborne Activity Confinement System, confinement over pressurization occurs. Thus, there is a large potential for an uncontrolled and unfiltered release of fission products from the confinement atmosphere to the environment at the time of the steam explosion. The GASFLOW computer code was used to analyze the effects of a hypothetical steam explosion and the transport of steam and hydrogen throughout a typical light-water reactor confinement building. The effects of rapid pressurization and the resulting forces on the internal structures and the heat exchanger service bay hatch covers were calculated. Pressurization of the ventilation system and the potential damage to the ventilation fans and high-efficiency particulate air filters were assessed. Because of buoyancy forces and the calculated confinement velocity field, the hydrogen diffuses and mixes in the confinement atmosphere but tends to be transported to its upper region.

5889 (LA-UR–94-2820) **Accident analysis for US fast burst reactors.** Paternoster, R. (Los Alamos National Lab., NM (United States)); Flanders, M.; Kazi, H. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941102–22: Winter meeting of the American Nuclear Society, Washington, DC (United States), 13-18 Nov 1994). Order Number DE94018288. Source: OSTI; NTIS; INIS; GPO Dep.

In the US fast burst reactor (FBR) community there has been increasing emphasis and scrutiny on safety analysis and understanding of possible accident scenarios. This paper summarizes recent work in these areas that is going on at the current US FBR sites. At this time, all of the FBR facilities have or in the process of updating and refining their accident analyses. This effort is driven by two objectives: to obtain a more realistic scenario for emergency response procedures and contingency plans, and to determine compliance with changing regulatory standards.

5890 (LA-UR–94-3143) **Coupled hydro-neutronic calculations for fast burst reactor accidents.** Paternoster, R.; Kimpland, R.; Jaegers, P.; McGhee, J. Los Alamos National Lab., NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941102–27: Winter meeting of the American Nuclear Society, Washington, DC (United States), 13-18 Nov 1994). Order Number DE95000858. Source: OSTI; NTIS; INIS; GPO Dep.

Methods are described for determining the fully coupled neutronic/hydrodynamic response of fast burst reactors (FBR) under disruptive accident conditions. Two code systems, PAD (1 -D Lagrangian) and NIKE-PAGOSA (3-D Eulerian) were used to accomplish this. This is in contrast to the typical methodology that computes these responses by either single point kinetics or in a decoupled manner. This methodology is enabled by the use of modern supercomputers (CM-200). Two examples of this capability are presented: an unreflected metal fast burst assembly, and a reflected fast burst assembly typical of the Skua or SPR-III class of fast burst reactor.

5891 (NUREG–0090-Vol.17-No.1) **Report to Congress on abnormal occurrences: January–March 1994. Volume 17, No. 1.** Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data. Aug 1994. 22p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence (AO) as an unscheduled incident or event that the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report provides a description of those events that have been determined to be abnormal occurrences during the period of January 1 through March 31, 1994. This report addresses seven AOs at NRC-licensed facilities. One involved inoperable main steam isolation valves at a boiling water reactor, four involved medical brachytherapy misadministrations, one involved a medical teletherapy misadministration, and one involved four lost reference sources. One AO that was reported by an Agreement State is also discussed; the information is current as of April 25, 1994. This event involved a therapeutic radiopharmaceutical misadministration. The report also contains updates on seven abnormal occurrences previously reported by NRC licensees and one abnormal occurrence previously reported by an Agreement State license. For the period January 1 to March 31, 1994, no new "Other Events of Interest" were reported but an update to a therapeutic misadministration previously reported as an "Other Event of Interest" is included.

5892 (NUREG–0713-Vol.15) **Occupational radiation exposure at commercial nuclear power reactors and other facilities, 1993. Volume 15, Twenty-six annual report.** Raddatz, C.T. (Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications); Hagemeyer, D. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Regulatory Applications. Jan 1995. 302p. Sponsored by Nuclear

Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This report the occupational radiation exposure information that has been reported to the NRC's Radiation Exposure Information Reporting System (REIRS) by nuclear power facilities and certain other categories of NRC licensees during the years 1969 through 1993. The bulk of the data presented in the report was obtained from annual radiation exposure reports submitted in accordance with the requirements of 10 CFR 20.407 and the technical specifications of nuclear power plants. Data on workers terminating their employment at certain NRC licensed facilities were obtained from reports submitted pursuant to 10 CFR 20.408. The 1993 annual reports submitted by about 360 licensees indicated that approximately 189,711 individuals were monitored, 169,872 of whom were monitored by nuclear power facilities. They incurred an average individual dose of 0.16 rem (cSv) and an average measured dose of about 0.31 (cSv). Termination radiation exposure reports were analyzed to reveal that about 99,749 individuals completed their employment with one or more of the 360 covered licensees during 1993. Some 91,000 of these individuals terminated from power reactor facilities, and about 12,685 of them were considered to be transient workers who received an average dose of 0.49 rem (cSv).

5893 (NUREG–1272-Vol.8-No.1) **Office for Analysis and Evaluation of Operational Data 1993 annual report: Volume 8, Number 1.** Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data. Nov 1994. 254p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This annual report of the US Nuclear Regulatory Commission's Office for Analysis and Evaluation of Operational Data (AEOD) describes activities conducted during 1993. The report is published in two parts. NUREG-1272, Vol. 8, No. 1, covers power reactors and presents an overview of the operating experience of the nuclear power industry from the NRC perspective, including comments about the trends of some key performance measures. The report also includes the principal findings and issues identified in AEOD studies over the past year and summarizes information from such sources as licensee event reports, diagnostic evaluations, and reports to the NRC's Operations Center. NUREG-1272, Vol. 8, No. 2, covers nuclear materials and presents a review of the events and concerns during 1993 associated with the use of licensed material in nonreactor applications, such as personnel overexposures and medical misadministrations. Both reports also contain a discussion of the Incident Investigation Team program and summarize both the Incident Investigation Team and Augmented Inspection Team reports. Each volume contains a list of the AEOD reports issued from 1980 through 1993.

5894 (NUREG/CP–0133-Vol.1, pp. 1-5) **Changing emphasis at the NRC's Office of Nuclear Regulatory Research.** Remick, F.J. (Nuclear Regulatory Commission, Bethesda, MD (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

One of the major objectives of the Office of Research is to ensure availability of sound technical information for timely decision making in support of the NRC's safety mission. The Office of Research is changing some of its emphasis to better meet the expected needs of the NRC's regulatory offices. Long-standing programs in support of operating reactors are nearing completion. These programs include plant aging and severe accident research for currently operating plants. This meeting will also address the new challenges faced by the NRC in its review of the advanced light water and non-light water reactors. As plant aging and severe accident research programs are nearing completion, the research activities are coming to focus on the emerging technologies, for example, digital instrumentation and control systems, both as replacement equipment for operating plants and as the technology of choice and necessity for the advanced reactors. Necessity, because analog equipment is becoming obsolete. Other examples include the use of new materials in operating plants, human factors considerations in the design and operation of the advanced plants, thermal-hydraulic characteristics of the advanced reactors, and new construction techniques.

5895 (NUREG/CP–0133-Vol.1, pp. 7-15) **Strategy of severe accident physical modeling in view of recent requirements to safety analysis.** Bolshov, L.A. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Nuclear power destiny in various states including Russia is not free from questions. Where there is plenty of non-expensive natural gas or coal in a country, the competition of nuclear power with other power sources is especially intense. Until one considers the economic efficiency or environmental impact of the normally operating plant, the estimate of the proponents favorite choice may be rather optimistic in many cases. As soon as safety aspects of nuclear power are concerned it is necessary to answer very significant questions about the dangers resulting from severe accidents. TMI and, to a greater extent, Chernobyl, demonstrated the other aspect of the severe accident problem. It serves no purpose to dwell upon the inadequate reaction of the population on the radiation problem. It is of little use to try to prove that the health consequences of the Chernobyl or some other radiation accident are substantially overestimated. To make an advance one must substantially reduce the severe accident risk. Besides that is is necessary to give a convincing proof that such a reduction has really been made.

5896 (NUREG/CP–0133-Vol.1, pp. 17-39) **Transient analysis of the PIUS advanced reactor design with the TRAC-PF1/MOD2 code.** Boyack, B.E. (Los Alamos National Lab., NM (United States)); Steiner, J.L.; Harmony, S.C.; Stumpf, H.J.; Lime, J.F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The PIUS advanced reactor is a 640-MWe pressurized water reactor developed by Asea Brown Boveri. A unique feature of the PIUS concept is the absence of mechanical control and shutdown rods. Reactivity is normally controlled by coolant boron concentration and the temperature of the moderator coolant. As part of the preapplication and eventual design certification process, advanced reactor applicants are required to submit neutronic and thermal-hydraulic safety analyses over a sufficient range of normal operation, transient conditions, and specified accident sequences. Los Alamos is supporting the US Nuclear Regulatory Commission's preapplication review of the PIUS reactor. Several models of the PIUS reactor have been developed for the system neutronic and thermal-hydraulic analysis code TRAC-PF1/MOD2. Analyses of five types of events have been completed. These are (1) reactor scram, (2) loss of offsite power, (3) main steam line break, (4) small-break loss-of-coolant, and (5) large-break loss-of-coolant. In addition to baseline calculations, sensitivity studies were performed to explore the robustness of the PIUS concept to severe off-normal

conditions. The sensitivity study results provide insights into the robustness of the design. The results of the Los Alamos analyses are summarized in this paper.

5897 (NUREG/CP–0133-Vol.1, pp. 41-69) **CANDU 3 transient analysis using AECL codes.** Shumway, R.W.; Judd, J.L.; Ebert, D.D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

A limited number of transient scenarios were calculated using a computer code suite and input modelling provided by the Atomic Energy of Canada Limited (AECL) for the CANDU 3 design. Emphasis was placed on a large-break loss-of-coolant accident with delays in actuation of the two independent shutdown systems (shutdown rods and liquid poison injection). Although this is expected to be an extremely unlikely scenario, it was studied because of the potential consequences which would result from a positive void coefficient of reactivity. Results indicate that a few second delay in shutdown would result in quickly reaching fuel or cladding melting temperatures, before the emergency core cooling system would be activated. Only small changes in the timing and consequences of the scenario result when several parameters, of potential importance to the progression of the accident, are varied. The severity of the accident is dramatically reduced when it is assumed that one of the two independent shutdown systems function as designed. The results presented in this paper are consistent with related studies performed by AECL and others, and do not reveal any new characteristics or phenomena.

5898 (NUREG/CP–0133-Vol.1, pp. 71-83) **Database and modeling assessments of the CANDU 3, PIUS, ALMR, and MHTGR designs.** Carlson, D.E.; Meyer, R.O. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

As part of the research program to support the preapplication reviews of the CANDU 3, PIUS, ALMR, and MHTGR designs, the NRC has completed preliminary assessments of databases and modeling capabilities. To ensure full coverage of all four designs, a detailed assessment methodology was developed that follows the broad logic of the NRC's Code Scaling, Applicability, and Uncertainty (CSAU) methodology. This paper describes the methodology of the database assessments and presents examples of the assessment process using preliminary results for the ALMR design.

5899 (NUREG/CP–0133-Vol.1, pp. 85-93) **Assessing functional diversity by program slicing.** Wallace, D.R. (National Institute of Standards and Technology, Gaithersburg, MD (United States)); Lyle, J.R.; Gallagher, K.B.; Ippolito, L.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

A responsibility of the Nuclear Regulatory Commission auditors is to provide assessments of the quality of the safety systems. For software, the audit process as currently implemented is a slow, tedious, manual process prone to human errors. While auditors cannot possibly examine all components of the system in complete detail, they do check for implementation of specific principles like functional diversity. This paper describes an experimental prototype Computer Aided Software Engineering (CASE) tool, UNRAVEL, designed to enable auditors to check for functional diversity and aid an auditor in examining software by extracting all code relevant to a computation identified for detailed inspection.

5900 (NUREG/CP–0133-Vol.1, pp. 95-119) **Software reliability assessment.** Barnes, M.; Bradley, P.A.; Brewer, M.A. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The increased usage and sophistication of computers applied to real time safety-related systems in the United Kingdom has spurred on the desire to provide a standard framework within which to assess dependable computing systems. Recent accidents and ensuing legislation have acted as a catalyst in this area. One particular aspect of dependable computing systems is that of software, which is usually designed to reduce risk at the system level, but which can increase risk if it is unreliable. Various organizations have recognized the problem of assessing the risk imposed to the system by unreliable software, and have taken initial steps to develop and use such assessment frameworks. This paper relates the approach of Consultancy Services of AEA Technology in developing a framework to assess the risk imposed by unreliable software. In addition, the paper discusses the experiences gained by Consultancy Services in applying the assessment framework to commercial and research projects. The framework is applicable to software used in safety applications, including proprietary software. Although the paper is written with Nuclear Reactor Safety applications in mind, the principles discussed can be applied to safety applications in all industries.

5901 (NUREG/CP–0133-Vol.1, pp. 121-140) **Class 1E software verification and validation: Past, present, and future.** Persons, W.L. (Lawrence Livermore National Lab., CA (United States)); Lawrence, J.D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract W-7405-ENG-48. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

This paper discusses work in progress that addresses software verification and validation (V&V) as it takes place during the full software life cycle of safety-critical software. The paper begins with a brief overview of the task description and discussion of the historical evolution of software V&V. A new perspective is presented which shows the entire verification and validation process from the viewpoints of a software developer, product assurance engineer, independent V&V auditor, and government regulator. An account of the experience of the field test of the Verification Audit Plan and Report generated from the V&V Guidelines is presented along with sample checklists and lessons learned from the verification audit

experience. Then, an approach to automating the V&V Guidelines is introduced. The paper concludes with a glossary and bibliography.

5902 (NUREG/CP–0133-Vol.1, pp. 141-147) **Comparison of the effect of paper and computerized procedures on operator error rate and speed of performance.** Converse, S.A. (North Carolina State Univ., Raleigh, NC (United States)); Perez, P.B.; Meyer, S.; Crabtree, W. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The Computerized Procedures Manual (COPMA-II) is an advanced procedure manual that can be used to select and execute procedures, to monitor the state of plant parameters, and to help operators track their progress through plant procedures. COPMA-II was evaluated in a study that compared the speed and accuracy of operators' performance when they performed with COPMA-II and traditional paper procedures. Sixteen licensed reactor operators worked in teams of two to operate the Scales Pressurized Water Reactor Facility at North Carolina State University. Each team performed one change of power with each type of procedure to simulate performance under normal operating conditions. Teams then performed one accident scenario with COPMA-II and one with paper procedures. Error rates, performance times, and subjective estimates of workload were collected, and were evaluated for each combination of procedure type and scenario type. For the change of power task, accuracy and response time were not different for COPMA-II and paper procedures. Operators did initiate responses to both accident scenarios fastest with paper procedures. However, procedure type did not moderate response completion time for either accident scenario. For accuracy, performance with paper procedures resulted in twice as many errors as did performance with COPMA-II. Subjective measures of mental workload for the accident scenarios were not affected by procedure type.

5903 (NUREG/CP–0133-Vol.1, pp. 149-160) **Validation of the use of network modeling of nuclear operator performance.** Lawless, M. (Micro Analysis and Design Inc., Boulder, CO (United States)); Laughery, R.; Persensky, J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Research and evaluation on human factors issues can be very expensive owing to (1) the high cost of running experiments and (2) high inter-team variability which makes it necessary to run large numbers of subjects to get stable estimates of performance. Increasingly, the engineering disciplines are looking towards computer modeling as a means of predicting performance as a function of engineering design. Human factors engineering has that goal as well. This paper presents the results of a validation study that evaluated a human performance modeling technology termed task network modeling. Task network models were built of a crew executing two emergency procedures and one normal procedure. For each of these three procedures, one model was built reflecting the use of paper procedures and one reflecting the use of computerized procedures. Model predictions were then compared to data on actual crews performing under identical conditions. In general, the model predictions were representative of actual performance, although a number of issues arose that should be addressed prior to using these models as a technical basis for regulatory action.

5904 (NUREG/CP–0133-Vol.1, pp. 161-172) **A review of potential uses for fiber optic sensors in nuclear power plants, with attendant benefits in plant safety and operational efficiency.** Holcomb, D.E. (Oak Ridge National Lab., TN (United States)); Antonescu, C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Fiber optic-based sensing has a wide range of potential applications in nuclear power plants, and a fiber optic analog presently exists for virtually every conventional nuclear power plant sensing system. Fiber optic-based sensors are likely to eventually supplant many conventional sensors because of their inherent advantages-reduced mass, reduced size, ruggedness to vibration and shock, physical flexibility, high sensitivity, electrical isolation, extreme resistance to electromagnetic interference, high temperature resistance, reduced calibration requirements, passive operation, and high radiation resistance. In addition, fiber optic-based sensors exist which are capable of measuring parameters important to safety and performance which cannot be conventionally measured (high electromagnetic field, in-core, and distributed measurements). However, fiber optic sensors remain at too low a level of development for immediate application in safety-critical systems. Moreover, fiber optic sensors have different failure modes and mechanisms than conventional sensors; hence, considerable regulatory research will be necessary to establish the technical basis for the use of fiber optic sensors in safety-critical systems.

5905 (NUREG/CP–0133-Vol.1, pp. 173-190) **Engineering the development of optical fiber sensors for adverse environments.** Hastings, M.C. (Ohio State Univ., Columbus, OH (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

During the last decade, many optical fiber sensors have been developed for particular applications in harsh environments with limited success. Off-the-shelf optical fiber sensors and measurement systems are not available, partly because they have not been engineered to meet tough environmental requirements necessary for applications outside the laboratory. Moreover, no generalized computer-aided tools exist to help advance their development, design, and use. Computer-aided design tools currently being developed are described in this paper. Structural finite element analyses have been coupled with optoelastic analyses of both all-fiber interferometers and serial microbend sensors for distributed measurement of various physical quantities. The combined analyses have been parameterized and implemented on personal computers and work stations for use as design/development tools that can be used to determine the performance of different sensor configurations in various environments. Potentially, these computer-aided tools could be used for failure diagnosis and redesign of existing optical fiber sensors. Performances predicted by the computer simulations are verified with experimental data and numerical analyses from the literature. The long-term goal is to develop user-friendly software packages for both sensor manufacturers and end users.

5906 (NUREG/CP–0133-Vol.1, pp. 219-228) **A dynamic fail-safe approach to the design of computer-based safety systems.** Smith, I.C. (AEA Technology, Dorset (United Kingdom)); Miller, M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

For over 30 years AEA Technology has carried out research and development in the field of nuclear instrumentation and protection systems. Throughout the course of this extensive period of research and development the dominant theme has been the achievement of fully fail-safe designs. These are defined as designs in which the failure of any single component will result in the unit output reverting to a demand for trip action status. At an early stage it was recognized that the use of dynamic rather than static logic could ease the difficulties inherent in achieving a fail-safe design. The first dynamic logic systems coupled logic elements magnetically. The paper outlines the evolution from these early concepts of a dynamic fail-safe approach to the design of computer-based safety systems. Details are given of collaboration between AEA Technology and Duke Power Co. to mount an ISAT™ demonstration at Duke's Oconee Nuclear Power Station.

5907 (NUREG/CP–0133-Vol.1, pp. 273-291) **Human factors issues in severe accident management: Training for decision-making under stress.** Mumaw, R.J. (Westinghouse Science and Technology Center, Pittsburgh, PA (United States)); Roth, E.M.; Schoenfeld, I. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Training for operator and other technical positions in the commercial nuclear power industry traditionally has focused on mastery of the formal procedures used to control plant systems and processes. However, there is a growing awareness that the decision-making tasks required for selecting appropriate control actions, in addition to guidance from formal procedures, also involve cognitive activities commonly referred to as judgment or reasoning. A project was completed to address the nature of the cognitive skills that may be important to decision-making in the nuclear power plant environment, especially during severe accident management. The project identified a model of decision-making that could account for both rule-based and knowledge-based decision-making and used it to identify cognitive skills for both individuals and operational crews. This analysis was then used to identify existing training techniques for cognitive skills and the general characteristics of successful training techniques.

5908 (NUREG/CP–0133-Vol.1, pp. 293-299) **Organization and management activities in the nuclear power industry.** Evans, R.C.; Whitesel, R.N. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The purpose of organization and management development activities in the commercial nuclear power industry is to foster high levels of power plant performance and safety through improved human performance. The NRC has been working to develop assessment tools to assay the effects of organizational factors on plant safety. The utility industry has been working on initiatives targeting individual accountability, the improvement of plant performance and the elimination of the items identified through the NRC assessment process. Organization and management activities do not focus on industry organizational charts, but on the personnel processes and dimensions (factors) that affect safety and economic performance. As individual terms these activities are often combined and referred to as organizational factors. As an area of study, organizational factors has become more prominent as the industry emphasis has switched in recent years from hardware issues related to safety and economics, to personnel-related issues. Beyond the obvious safety objectives affected by improved human performance, plant performance improvements, in areas such as capacity factors, can be achieved through improved human performance. For example, it is estimated that as many as half of the unplanned reactor scrams are caused by personnel errors. The integrated effect of these scram-initiating errors is conservatively estimated to be 100 lost capacity days per year. The financial impact of these events is estimated to be $100M per year.

5909 (NUREG/CP–0133-Vol.1, pp. 301-308) **Potential human factors research relating to modern technology in nuclear power plants.** Ketchel, J. (EPRI, Palo Alto, CA (United States)); Fink, R.; Hanes, L.; Williges, R.; Williges, B. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

This paper discusses proposed human factors research to address advanced human-machine interface technology in nuclear power plants. It relates to a current EPRI project to identify a prioritized list of specific research issues that could be assessed to improve control room and other user interface areas. The project seeks to bridge the gap between the functional requirements of advanced design initiatives and the human factors research needed to support them. It seeks to identify potential benefits to be expected, as well as potential problems that might be introduced by advanced technology. It provides an organized approach to identifying human factors research needs, information already available, and measures of performance and effectiveness that might be used to assess the value of potential improvements. Those parts of the proposed plan that are subsequently approved by EPRI management and by the utility advisory committee will provide a basis for recommending research priorities.

5910 (NUREG/CP–0133-Vol.1, pp. 309-312) **An assessment of human factors research facilities and capabilities for the US NRC.** Barnes, V.; Parsons, S.O.; Laughery, K.R.; Wachtel, J.; Persensky, J.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The Human Factors Branch of the Nuclear Regulatory Commission's (NRC) Office of Nuclear Regulatory Research is sponsoring a study to identify the need for and availability of additional facilities for supporting human factors regulatory research. The

objectives of the study are to: (1) determine the availability and capabilities of existing research facilities to support the current and expected human factors regulatory research needs of the NRC; (2) determine the need, if any, for an enhancement of, or supplement to the present human factors research facilities by detailing those regulatory research needs, current and expected, that cannot be met with existing facilities, or that cannot be performed at these facilities; (3) specify the characteristics of facilities that would be required to support these needs; and (4) perform a cost-benefit study of possible alternatives. The methods and preliminary findings of this on-going effort are described.

5911 (NUREG/CP–0133-Vol.1, pp. 313-325) **Implications of an HRA framework for quantifying human acts of commission and dependency: Development of a methodology for conducting an integrated HRA/PRA.** Barriere, M.T. (Brookhaven National Lab., Upton, NY (United States)); Luckas, W.J.; Brown, W.S.; Cooper, S.E.; Wreathall, J.; Bley, D.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

To support the development of a refined human reliability analysis (HRA) framework, to address identified HRA user needs and improve HRA modeling, unique aspects of human performance have been identified from an analysis of actual plant-specific events. Through the use of the refined framework, relationships between the following HRA, human factors and probabilistic risk assessment (PRA) elements were described: the PRA model, plant states, plant conditions, PRA basic events, unsafe human actions, error mechanisms, and performance shaping factors (PSFs). The event analyses performed in the context of the refined HRA framework, identified the need for new HRA methods that are capable of: evaluating a range of different error mechanisms (e.g., slips as well as mistakes); addressing errors of commission (EOCs) and dependencies between human actions; and incorporating the influence of plant conditions and multiple PSFs on human actions. This report discusses the results of the assessment of user needs, the refinement of the existing HRA framework, as well as, the current status on EOCs, and human dependencies.

5912 (NUREG/CP–0133-Vol.1, pp. 327-337) **Results and insights of a level-1 internal event PRA of a PWR during mid-loop operations.** Chu, T.L. (Brookhaven National Lab., Upton, NY (United States)); Musicki, Z.; Kohut, P.; Yang, J.; Bozoki, G.; Hsu, C.J.; Diamond, D.J.; Wong, S.M.; Holmes, B.; Su, R.F.; Dang, V.; Siu, N.; Bley, D.; Johnson, D.; Lin, J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Traditionally, probabilistic risk assessments (PRA) of severe accidents in nuclear power plants have considered initiating events potentially occurring only during full power operation. Some previous screening analysis that were performed for other modes of operation suggested that risks during those modes were small relative to full power operation. However, more recent studies and operational experience have implied that accidents during low power and shutdown could be significant contributors to risk. During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects being performed by BNL and SNL. Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied. The objectives of the program are to assess the risks of severe accidents initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The scope of the program includes that of a level-3 PRA. The objective of this paper is to present the approach utilized in the level-1 PRA for the Surry plant, and discuss the results obtained. A comparison of the results with those of other shutdown studies is provided. Relevant safety issues such as plant and hardware configurations, operator training, and instrumentation and control is discussed.

5913 (NUREG/CP–0133-Vol.1, pp. 395-414) **The capabilities and applications of the saphire 5.0 safety assessment software.** Russell, K.D. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Wood, S.T.; Kvarfordt, K.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The System Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) refers to a suite of computer programs that were developed to create and analyze a probabilistic risk assessment (PRA) of a nuclear power plant. The programs in this suite include: Models and Results Data Base (MAR-D) software, Integrated Reliability and Risk Analysis System (IRRAS) software, System Analysis and Risk Assessment (SARA) software, and Fault tree, Event tree, and Piping and instrumentation diagram (FEP) graphical editor. Each of these programs performs a specific function in taking a PRA from the conceptual state all the way to publication. This paper provides an overview of the features and capabilities provided in version 5.0 of this software system. Some major new features include the ability to store unlimited cut sets, the ability to perform location transformations, the ability to perform seismic analysis, the ability to perform automated rule based recovery analysis and end state cut set partitioning, the ability to perform end state analysis, a new alphanumeric fault tree editor, and a new alphanumeric event tree editor. Many enhancements and improvements to the user interface as well as a significant reduction in the time required to perform an analysis are included in version 5.0. These new features and capabilities provide a powerful set of PC based PRA analysis tools.

5914 (NUREG/CP–0133-Vol.1, pp. 415-425) **Experiments on a scaled loop.** Doster, J.M. (North Carolina State Univ., Raleigh, NC (United States)); Giavedoni, E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The Scaled PWR Facility (SPWRF) in the Nuclear Engineering Department at North Carolina State Univ. is being used to study the effectiveness of two phase natural circulation and reflux cooling under conditions associated with loss of forced circulation, mid-loop coolant levels and noncondensables in the primary coolant system. Of interest are the conditions under which the noncondensables can be sufficiently compressed to expose significant portions of the heat transfer area to condensation. Of additional interest is the

magnitude and time duration of the primary side pressure excursion resulting from loss of heat removal capability in the steam generators. The NCSU Scaled PWR Facility is a Freon based, 1/9 scale model of a two-loop Westinghouse Pressurized Water Reactor. Both primary and secondary sides are represented including such normal balance of plant components as condensers, condensate and feed pumps, and Feedwater heaters. The first phase of this work has involved measurements of steady state heat transfer rates under reflux cooling as a function of primary and secondary side pressure in the absence of noncondensables. Other key parameters measured include hot leg liquid and vapor temperatures, vapor velocities and liquid level. These results provide benchmark data for modeling of the reflux cooling process.

5915 (NUREG/CP–0133-Vol.1, pp. 427-444) **Core to surgeline energy transport in a severe accident scenario.** Marzo, M. di (Univ. of Maryland, College Park, MD (United States)); Almenas, K.; Gopalnarayanan, S. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The analysis of loss of coolant accidents in a nuclear power plant, which progress to the stage where the core is uncovered, poses important safety related questions. One of these concerns the rate of energy transport to metal components of the primary system. An experimental program has been conducted at the Univ. of Maryland test facility which quantifies the rate of energy transfer from an uncovered core in a B&W (once-through type steam generators) plant. SF_6 is used to simulate the natural circulation driving force of the high pressure steam expected at prototypical conditions. A time-dependent scaling methodology is developed to transpose experimental data to prototypical conditions. To achieve this transformation, a nominal fluid temperature increase rate of 1.0°C/s is inferred from available TMI-2 event data. To bracket the range of potential prototypical transient scenarios, temperature ramps of 0.8°C/s and 1.2°C/s are also considered. Repeated tests, covering a range of test facility conditions, lead to estimated failure times at the surge line nozzle of 1.5 to 2 hours after initiation of the natural circulation phase of the transient.

5916 (NUREG/CP–0133-Vol.1, pp. 445-468) **Assessment of the potential for HPME during a station blackout in the Surry and Zion PWRS.** Knudson, D.L. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Bayless, P.D.; Dobbe, C.A.; Odar, F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The integrity of a PWR (pressurized water reactor) containment structure could be challenged by direct heating associated with a HPME (high pressure melt ejection) of core materials following reactor vessel lower head breach during certain severe accidents. Structural failure resulting from direct containment heating is a contributor to the risk of operating a PWR. Intentional RCS (reactor coolant system) depressurization, where operators latch pressurizer relief valves open, has been proposed as an accident management strategy to reduce those risks by mitigating the severity of the HPME. However, decay heat levels, valve capacities, and other plant-specific characteristics determine whether the required operator action will be effective. Without operator action, natural circulation flows could heat ex-vessel RCS pressure boundaries (surge line and hot leg piping, steam generator tubes, etc.) to the point of failure before failure of the lower head providing an unintentional mechanism for depressurization and HPME mitigation. This paper summarizes an assessment of RCS depressurization with respect to the potential for HPME during a station blackout in the Surry and Zion PWRs. The assessment included a detailed transient analysis using the SCDAP/RELAP5/MOD3 computer code and an evaluation of RCS depressurization-related probabilities primarily based on the code results.

5917 (NUREG/CP–0133-Vol.1, pp. 469-475) **Peer review of RELAP5/MOD3 documentation.** Craddick, W.G. (Oak Ridge National Lab., TN (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

A peer review was performed on a portion of the documentation of the RELAP5/MOD3 computer code. The review was performed in two phases. The first phase was a review of Vol. III, Developmental Assessment Problems, and Vol. IV, Models and Correlations. The reviewers for this phase were Dr. Peter Griffith, Dr. Yassin Hassan, Dr. Gerald S. Lellouche, Dr. Marino di Marzo and Mr. Mark Wendel. The reviewers recommended a number of improvements, including using a frozen version of the code for assessment guided by a validation plan, better discussion of discrepancies between the code and experimental data, and better justification for flow regime maps and extension of models beyond their data base. The second phase was a review of Vol. VI, Quality Assurance of Numerical Techniques in RELAP5/MOD3. The reviewers for the second phase were Mr. Mark Wendel and Dr. Paul T. Williams. Recommendations included correction of numerous grammatical and typographical errors and better justification for the use of Lax's Equivalence Theorem.

5918 (NUREG/CP–0133-Vol.1, pp. 477-487) **Benchmark analyses with RELAP5 for USNRC simulators.** Burtt, J.D. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Martin, R.P.; Bell, L. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The US Nuclear Regulatory Commission adopted the Kemeny Commission recommendations that all nuclear plants have a plant specific simulator for operator training. In support of this requirement a project was initiated to examine the capabilities of the current generation of simulators using advanced thermal hydraulic systems codes such as RELAP5 and TRAC-B. As part of the project, RELAP5 models of Pressurized Water Reactor simulators at the US Nuclear Regulatory Commission's Technical Training Center have been developed and sets of transients performed for comparison with simulator predictions. One such model was for the Washington Nuclear Project Unit 1 Simulator. Thermal-hydraulic analyses of five hypothetical accident scenarios were performed with the RELAP5/MOD3 computer code, then the same scenarios performed on the simulator, prior to a scheduled upgrade with S3 Technology's RETACT simulator code. The five transients performed were: (1) Loss of AC power, (2) Small Break Loss of Coolant Accident with Loss of AC power, (3) Stuck open Pressurizer Safety Valve, (4) Main Steamline Break with Steam Generator

Tube Rapture, and (5) Loss of main Feedwater with Delayed Scram. Comparison of code and simulator data was performed by reviewing each transient with a team of plant analysts and experienced reactor operators. The initial findings show that both the simulator and system codes' modeling need improvement. The conclusion drawn from this preliminary study is that simulator benchmarking is and should be a dynamic, iterative process with benefits for both simulator engineers and plant analysts.

5919 (NUREG/CP–0133-Vol.1, pp. 489-509) **Depressurization as an accident management strategy to minimize direct containment heating.** Brownson, D.A. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Odar, F. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC07-76ID01570. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

In a previous investigation of the Surry nuclear power station, it was concluded that intentional depressurization of the reactor coolant system could prevent or mitigate the effects of direct containment heating during a TMLB' station blackout transient. By applying appropriate scaling factors, the results of the Surry analysis were extended to other US pressurized water reactors (PWRs) in order to evaluate their capability to successfully employ the intensional depressurization strategy. This extension resulted in the categorization of four PWR groups. A representative from each PWR group was then chosen for evaluation. The phenomenological behavior, equipment reliability, and operational performance of these PWRs during the intentional depressurization strategy was considered. These evaluations were then used to provide an indication of the capability of the remaining members of each PWR group to employ the intentional depressurization strategy.

5920 (NUREG/CP–0133-Vol.1, pp. 511-520) **NRC confirmatory safety system testing in support of AP600 design review.** Rhee, G.S.; Bessette, D.E.; Shotkin, L.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Westinghouse Electric Corporation has submitted the Advanced Passive 600 MWe (AP600) nuclear power plant design to the NRC for design certification. The Office of Nuclear Regulatory Research is proceeding to conduct confirmatory testing to help the NRC staff evaluate the AP600 safety system design. For confirmatory testing, it was determined that the cost-effective route was to modify an existing full-height, full-pressure test facility rather than build a new one. Thus, all the existing integral effects test facilities, both in the US and abroad, were screened to select the best candidate. As a result, the ROSA-V (Rig of Safety Assessment-V) test facility located in the Japan Atomic Energy Research Institute (JAERI) was chosen. However, because of some differences in design between the existing ROSA-V facility and the AP600, the ROSA-V is being modified to conform to the AP600 safety system design. The modification work will be completed by the end of this year. A series of facility characterization tests will then be performed in January 1994 for the modified part of the facility before the main test series is initiated in February 1994. A total of 12 tests will be performed in 1994 under Phase I of this cooperative program with JAERI. Phase II testing is being considered to be conducted in 1995 mainly for beyond-design-basis accident evaluation.

5921 (NUREG/CP–0133-Vol.1, pp. 521-529) **NRC Confirmatory Testing Program for SBWR.** Han, J.T. (Nuclear Regulatory Commission, Washington, DC (United States)); Bessette, D.E.; Shotkin, L.M. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The objective of the NRC Confirmatory Testing Program for SBWR is to provide integral data for code assessment, which reasonably reproduce the important phenomena and processes expected in the SBWR under various loss-of-coolant accident (LOCA) and transient conditions. To achieve this objective, the Program consists of four coupled elements: (1) to design and construct an integral, carefully-scaled SBWR test facility at Purdue Univ., (2) to provide pre-construction RELAP5/CONTAIN predictions of the facility design, (3) to provide confirmatory data for code assessment, and (4) to assess the RELAP5/CONTAIN code with data. A description of the "preliminary design" of the Purdue test facility and test matrix is presented. The facility is scheduled to be built by December 1994. Approximately 50 tests will be performed from April 1995 through April 1996 and documented by interim data reports. A final and complete data report is scheduled to be published by July 31, 1996.

5922 (NUREG/CP–0133-Vol.1, pp. 531-547) **RELAP5/MOD3 calculations for GIST data.** Jones, K.R. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Determan, J.C.; McCreery, G.E.; Han, J.T. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

An input deck for the thermal-hydraulic modeling code RELAP5/MOD3 was constructed to simulate the Gravity Driven Cooling System (GDCS) Integrated Systems Test (GIST) facility. The GIST facility was operated by General Electric at their site in San Jose, CA, as part of the GDCS test program. Capabilities and limitations of the database generated during the test program with respect to code assessment are discussed. Five calculations were performed with the RELAP5/MOD3 GIST model. The calculations include four loss-of-coolant accident calculations (LOCAs) and one feedwater trip calculation. The results of the calculations are presented, including a discussion of code errors found and corrected.

5923 (NUREG/CP–0133-Vol.1, pp. 563-587) **Ramona-4B development for SBWR safety studies.** Rohatgi, U.S. (Brookhaven National Lab., Upton, NY (United States)); Aronson, A.L.; Cheng, H.S.; Khan, H.J.; Mallen, A.N. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

The Simplified Boiling Water Reactor (SBWR) is a revolutionary design of a boiling-water reactor. The reactor is based on passive safety systems such as natural circulation, gravity flow, pressurized gas, and condensation. SBWR has no active systems, and the flow

in the vessel is by natural circulation. There is a large chimney section above the core to provide a buoyancy head for natural circulation. The reactor can be shut down by either of four systems; namely, scram, Fine Motion Control Rod Drive (FMCRD), Alternate Rod Insertion (ADI), and Standby Liquid Control System (SLCS). The safety injection is by gravity drain from the Gravity Driven Cooling System (GDCS) and Suppression Pool (SP). The heat sink is through two types of heat exchangers submerged in the tank of water. These heat exchangers are the Isolation Condenser (IC) and the Passive Containment Cooling System (PCCS). The unique design of SBWR imposes new requirements on the analytic methods for modeling its behavior. The close coupling between the power and flow, and also flow distribution among the parallel channels require a multidimensional power-prediction capability. The startup of the reactor has vapor generation and condensation taking place in the core requiring a model with a non-homogeneous, nonequilibrium, two-phase formulation. The instability at low flow/high power conditions requires modeling of the control systems and balance of plant, which has significant impact on the amplitude of the instability-induced power and flow oscillations. The RAMONA-4B code has been developed to simulate the normal operation, reactivity transients, and to address the instability issues for SBWR. The objective of this project is develop a Sun SPARC and IBM RISC 6000 based RAMONA-4B code for applications to SBWR safety analyses, in particular for stability and ATWS studies.

5924 (NUREG/CP–0133-Vol.3, pp. 3-26) **Biaxial loading and shallow-flaw effects on crack-tip constraint and fracture-toughness.** Pennell, W.E. (Oak Ridge National Lab., TN (United States)); Bryson, J.W.; McAfee, W.J.; Theiss, T.J.; Bass, B.R.; Rao, M.C. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Uniaxial tests of single-edged notched bend (SENB) specimens with both deep- and shallow-flaws have shown elevated fracture-toughness for the shallow flaws. The elevation in fracture-toughness for shallow flaws has been shown to be the result of reduced constraint at the crack-tip. Biaxial loading has the potential to increase constraint at the crack-tip and thereby reduce some of the shallow-flaw, fracture-toughness elevation. Biaxial fracture-toughness tests have shown that the shallow-flaw, fracture-toughness elevation is reduced but not eliminated by biaxial loading. Dual-parameter, fracture-toughness correlations have been proposed to reflect the effect of crack-tip constraint on fracture-toughness. Test results from the uniaxial and biaxial tests were analyzed using the dual-parameter technology. Discrepancies between analysis results and cleavage initiation site data from fractographic examinations indicate that the analysis models are in need of further refinement. Addition of a precleavage, ductile-tearing element to the analysis model has the potential to resolve the noted discrepancies.

5925 (NUREG/CP–0133-Vol.3, pp. 81-93) **Modeling of irradiation embrittlement and annealing data.** Eason, E.D. (Modeling & Computing Services, Newark, CA (United States)); Wright, J.E.; Nelson, E.E. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. Contract NRC-04-92-048. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

This project is developing improved irradiation embrittlement equations based on the current understanding of embrittlement mechanisms and the increased amount of embrittlement data that has become available in recent years. The primary sources of data are the Power Reactor Embrittlement Database (PR-EDB) and the Test Reactor Embrittlement Database (TR-EDB) compiled at Oak Ridge National Laboratory. Results from mechanistic studies and advanced statistical techniques, including pattern recognition and transformation analysis, are being used to identify potential modeling variables and their functional forms. An important part of the project is modeling the effectiveness of annealing countermeasures. This paper is focused on the annealing part of the project. Preliminary models for recovery in transition temperature and Charpy upper shelf energy due to annealing are presented.

5926 (NUREG/CP–0133-Vol.3, pp. 95-110) **VVER-440 dosimetry and neutron spectrum benchmark.** Sajo, E. (Louisiana State Univ. Nuclear Science Center, Baton Rouge, LA (United States)); Kam F.B.K. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. DOE Contract AC05-84OR21400. (CONF-931079–Vol.3: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Twenty-First Water Reactor Safety Information Meeting. Volume 3, Primary system integrity; Aging research, products and applications; Structural and seismic engineering; Seismology and geology: Proceedings.* 433p. Source: OSTI; NTIS; INIS; GPO.

Light Water Reactor (LWR) benchmark experiments performed in the United States under the Surveillance Dosimetry Improvement Program (SDIP), in general, reported measured reaction rates and not neutron flux spectrum. The VVER-440 benchmark experiments, using a combination of spherical hydrogen-filled proportional counters and a stilbene scintillator detector, were measurements that provided a direct verification of the transport neutron flux spectrum. The original SAILOR cross-section library from ENDF/B-IV were used, except that the iron, hydrogen, and oxygen values from ENDF/B-VI were inserted. A linear-least-squares analysis showed that the average difference between calculations and measurements below 10 MeV was (a) less than 6% at the surveillance position; (b) less than 5% at the pressure vessel (PV) inner surface; (c) less than 6% at 1/3 thickness into the PV (1/3 T); (d) less than 17% at 2/3 thickness into the PV (2/3 T); and (e) less than 24% at the PV outer surface.

5927 (NUREG/CP–0136, pp. 5-7) **Welcome: Commissioner Kenneth C. Rogers.** Rogers, K.C. (Nuclear Regulatory Commission, Rockville, MD (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

As you know, the primary concern of the NRC is the protection of the public health and safety. A major component of the NRC's defense-in-depth philosophy is the control and safety systems associated with nuclear reactors. Until quite recently, these instrumentation and control (I&C) systems have all been analog systems, and for several reasons the nuclear industry in the US has been slow in adopting the new digital technology in their plants. However, in part due to lack of available replacement parts for old systems, and in part due to the overwhelming advantages of digital over analog systems, that can no longer be ignored, the regulated community is starting to move toward digitization of nuclear power plant I&C systems at an escalating pace.

5928 (NUREG/CP–0136, pp. 9-12) **Welcome and opening statement.** Beckjord, E.S. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The purpose of the Workshop is to discuss the application of advanced digital systems technology to operations and control of nuclear power plants, now and in the future, in ways that will enhance safety. In particular the NRC expects to hear from experts

outside of NRC on safety issues and R&D related to state-of-the-art digital systems in NPPs. In preparation for this Workshop, the NRC has provided staff draft technical position papers on regulatory review of digital systems for replacement of original control systems in operating plants, and in proposed advanced NPPs. The NRC welcomes comments on these papers in the course of the meeting, and intends to take account of these comments, and the important ideas that arise at the meeting, in making the draft papers final.

5929 (NUREG/CP–0136, pp. 13-15) **Welcome and ACRS perspective.** Wilkins, J.E. Jr. (Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

Almost exactly one year ago ACRS sent a report to the Chairman of the NRC in which it commented on some of the obvious advantages and disadvantages of digital technology for instrumentation and/or control systems, with particular reference to their implications for nuclear industry regulators. The Committee observed that the NRC staff had, at that time "concentrated its attention on the vulnerability of digital systems to certain kinds of common-mode failures, principally through programming errors introduced into the software." The Committee recommended that the NRC staff revisit some of the less desirable proposed regulatory requirements, augment staff capabilities in the digital technology area, and look at other industries which have dealt with similar problems.

5930 (NUREG/CP–0136, pp. 31-45) **NRC Research activities.** Beltracchi, L. (Nuclear Regulatory Commission, Washington, DC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

This paper identifies and describes safety issues related to the design, development, and qualification of reliable digital computer systems for nuclear power plants. It also describes the U.S. Nuclear Regulatory Commission's research program on these issues. The paper discusses an evaluation of the initial standards for hardwired based safety systems. The lessons learned in developing these standards provides guidance in the design and use of digital technology in nuclear power plants. Also, this evaluation discusses how the content of the standards should lead to a framework of design criteria and the related acceptance criteria that can be used for computer-based safety systems. The opinions and viewpoints expressed herein are the author's personal ones and they do not necessarily reflect the criteria, requirements, and guidelines of the U.S. Nuclear Regulatory Commission (NRC).

5931 (NUREG/CP–0136, pp. 61-79) **Experiences from application of digital systems in nuclear power plants.** Joannou, P.K. (Ontario Hydro, Toronto, Ontario (Canada)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

Digital systems have been integral to CANDU nuclear power plants from their inception 25 years ago. The four most recently commissioned CANDU generating units at the Darlington Nuclear Generating Station have the highest degree of incorporation of digital systems of the 20 units operated by Ontario Hydro. Darlington was the first CANDU plant to use digital systems for the complete safety shutdown function. The use of digital systems in the shutdown systems at Darlington led to some licensing issues that required a substantial effort by Ontario Hydro and Atomic Energy Canada Limited (AECL), the designers of the shutdown systems, to address. Ontario Hydro's years of experience with digital systems and their experience in addressing the Darlington licensing issues were used to develop an approach to engineering digital systems for nuclear power plants. The approach is documented in a family of standards, procedures and guidelines. This paper defines the licensing issues that needed to be addressed for Darlington shutdown systems, defines the expectations of the regulator and the utility with respect to the approach, describes the approach itself, describes the issues that still require further work, and describes the status of the work program that is in place at Ontario Hydro and AECL to address outstanding issues and continually improve the approach.

5932 (NUREG/CP–0136, pp. 81-106) **Hardware aspects of safety critical digital computer based instrumentation and control systems.** Sudduth, A.L. (Duke Power Company, Charlotte, NC (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

During the last 20 years, instrumentation and control systems based on digital computer technology have come to be used widely throughout industry. Included are applications that are of a safety critical nature - that is, where the consequences of failure of a device or system could have substantial adverse impact on the public. The successful application of digital computer technology in the aerospace and process industries for monitoring and control, and the benefits that this technology offers when compared to the analog technology of 25 years ago, require that consideration be given to the more widespread application of digital computer technology in US nuclear stations as obsolete monitoring and control systems are replaced. The purpose of this paper is to examine hardware aspects of safety critical digital control and instrumentation systems. It will discuss how to achieve adequate measures of system reliability and how to ensure that the required level to reliability is achieved. Special techniques for design of the hardware architecture of a digital computer based monitoring and control system that are able to make the system single or even double failure proof are discussed. Examples of hardware architectures which achieve high reliability are given, including those currently in use in US nuclear stations or expected to be applied in the future.

5933 (NUREG/CP–0136, pp. 107-108) **Software aspects for safety-critical systems.** Cherniavsky, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The author discusses efforts made by the National Science Foundation to support research aimed at software engineering concerns which bear on the reliability of systems. Such engineering work would contribute to the issues of concern to the NRC with regard to digital control systems in nuclear power plants.

5934 (NUREG/CP–0136, pp. 109-132) **Human aspects for safety-critical systems.** Hanes, L.F. (Ohio State Univ., Columbus, OH (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

This report addresses crew, i.e., human, aspects of the widespread introduction of digital technology into nuclear power plant control rooms. Such changes as increased levels of automation, intelligent electronic displays, and compact work stations influence crew situation awareness, workload, etc. The overall impact is expected to be enhanced safety, although such challenges

as automation complacency and access to information in multi-dimensional space must be handled. In considering design certification for safety, it is desirable that guidelines be available. Since digital technology is developing more rapidly than accepted guidelines, regulatory emphasis is placed on the design process and verification and validation. The lack of adequate guidance creates a need to assess knowledge from other applications already experienced with digital technology (e.g., foreign nuclear and fossil plant upgrades, commercial aviation), and to perform application research on such topics as automation and information management.

5935 (NUREG/CP–0136, pp. 133-138) **Interaction between systems and software engineering in safety-critical systems.** Knight, J. (Univ. of Virginia, Charlottesville, VA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

There are three areas of concern: when is software to be considered safe; what, exactly, is the role of the software engineer; and how do systems, or sometimes applications, engineers and software engineers interact with each other. The author presents his perspective on these questions which he feels differ from those of many in the field. He argues for a clear definition of safety in the software arena, so the engineer knows what he is engineering toward. Software must be viewed as part of the entire system, since it does not function on its own, or isolation. He argues for the establishment of clear specifications in this area.

5936 (NUREG/CP–0136, pp. 139-147) **The role of formal specifications.** McHugh, J. (Portland State Univ., Portland, OR (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The role of formal requirements specification is discussed under the premise that the primary purpose of such specifications is to facilitate clear and unambiguous communications among the communities of interest for a given project. An example is presented in which the failure to reach such an understanding resulted in an accident at a chemical plant. Following the example, specification languages based on logical formalisms and notations are considered. These are rejected as failing to serve the communications needs of diverse communities. The notion of a specification as a surrogate for a program is also considered and rejected. The paper ends with a discussion of the type of formal notation that will serve the communications role and several encouraging developments are noted.

5937 (NUREG/CP–0136, pp. 149-161) **Specification-based testing: What is it? How can it be automated?.** Poston, R.M. (Interactive Development Envir., Tinton Falls, NJ (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

Software testing should begin with a written requirements specification. A specification states how software is expected to behave and describes operational characteristics (performance, reliability, etc.) for the software. A specification serves as a reference or base to test against, giving rise to the name, specification-based testing. Should analysts or designers fail to write a specification, then testers are obliged to write their own specification to test against. Specifications written by testers may be called test plans or test objectives.

5938 (NUREG/CP–0136, pp. 163-195) **Applicability of object-oriented design methods and C++ to safety-critical systems.** Cuthill, B.B. (National Institute of Standards and Technology, Gaithersburg, MD (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

This paper reports on a study identifying risks and benefits of using a software development methodology containing object-oriented design (OOD) techniques and using C++ as a programming language relative to selected features of safety-critical systems development. These features are modularity, functional diversity, removing ambiguous code, traceability, and real-time performance.

5939 (NUREG/CP–0136, pp. 197-211) **Automated tools for safety-critical software.** Lapassat, A.M. (CEN/SACLAY-IRDI/D, LET/DEIN/SUR, GIF SUR Yvette (France)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

In France, the licensing process of nuclear power plants includes a detailed survey of the nuclear reactor Instrumentation and Control and in particular of the Protection System which is classified as a Safety Critical System. The Safety of such a system is mainly insured by the quality of the development process including separated teams for development and Validation. However, before acceptance, an independent evaluation is realized by Institute for Protection and Nuclear Safety (IPSN), comprising a critical examination of the documents, an assessment of the code quality, and identification of the critical software components, a choice and preparation of tests cases, and dynamical verifications of consistency and robustness. To help that Independent Verification & Validation (IV&V) process, the tool CLAIRE-OST was developed at CEA-DEIN to cover dynamical verifications. Based on the principle of test by simulation, it is independant of the specification methods and languages used by the Safety Critical System Provider and it is flexible enough to allow different types of modelling and categories of test. Further development consists of helping the generation of test cases, based on proof techniques and formal models of specifications.

5940 (NUREG/CP–0136, pp. 213-217) **The risks of safety-critical systems.** Royce, W. (TRW, Inc., Fairfax, VA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The author raises six points with regard to the evaluation of safety-critical systems, which based on other similar systems, have been observed to be of concern. They are: safety-critical systems are implemented in the wrong languages; there are not enough tools for safety-critical systems development; there is insufficient analysis and distribution of error measurement data; there is no organizational certification; there is no people certification; and there is infrequent graspability of the full system functionality.

5941 (NUREG/CP–0136, pp. 219-224) **Integrated modeling of software cost and quality.** Rone, K.Y. (IBM Corp., Houston, TX (United States)); Olson, K.M. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital*

Systems Reliability and Nuclear Safety Workshop. 368p. Source: OSTI; NTIS; INIS.

In modeling the cost and quality of software systems, the relationship between cost and quality must be considered. This explicit relationship is dictated by the criticality of the software being developed. The balance between cost and quality is a viable software engineering trade-off throughout the life cycle. Therefore, the ability to accurately estimate the cost and quality of software systems is essential to providing reliable software on time and within budget. Software cost models relate the product error rate to the percent of the project labor that is required for independent verification and validation. The criticality of the software determines which cost model is used to estimate the labor required to develop the software. Software quality models yield an expected error discovery rate based on the software size, criticality, software development environment, and the level of competence of the project and the developers with respect to the processes being employed.

5942 (NUREG/CP–0136, pp. 225-228) **Software reliability for safety-critical applications.** Everett, B. (AT&T Bell Laboratories, Holmdel, NJ (United States)); Musa, J. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

In this talk, the authors address the question "Can Software Reliability Engineering measurement and modeling techniques be applied to safety-critical applications?" Quantitative techniques have long been applied in engineering hardware components of safety-critical applications. The authors have seen a growing acceptance and use of quantitative techniques in engineering software systems but a continuing reluctance in using such techniques in safety-critical applications. The general case posed against using quantitative techniques for software components runs along the following lines: safety-critical applications should be engineered such that catastrophic failures occur less frequently than one in a billion hours of operation; current software measurement/modeling techniques rely on using failure history data collected during testing; one would have to accumulate over a billion operational hours to verify failure rate objectives of about one per billion hours.

5943 (NUREG/CP–0136, pp. 229-245) **Software configuration management for safety-critical systems.** Berlack, H.R. (Configuration Management International, Anherst, NJ (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

This paper describes how the Software Configuration Management Process (SCM) can contribute to the successful accomplishment of development and maintenance of Safety-critical Software in the Nuclear Reactor System's environment. SCM is the management of the software product as it evolves through development and operates in a designated system. SCM acts as a communicator for the development/maintainer activities through the process of identification of the software product's requirements, design and associated interfaces, establishing baselines, managing changes, reporting status and performing audits.

5944 (NUREG/CP–0136, pp. 247-255) **How much software verification and validation is adequate for nuclear safety?.** Fujii, R.U. (Logicon, Inc., Bellevue, NE (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

For over 26 years, software verification and validation (V&V) has been applied to major DOD weapon systems, especially nuclear weapon systems, to ensure that the software is free of catastrophic software errors. Software V&V is a systems engineering discipline that evaluates the software as part of the entire system including hardware, human operators, and other interfacing software. When applied from a systems perspective, software V&V has been proven to be an effective technique for the early detection and correction of errors. Several V&V cost/benefit case studies for the Rome Air Development Center have shown that the dollar savings of the early detection of errors clearly offset the cost of the software V&V.

5945 (NUREG/CP–0136, pp. 257-265) **Fault-specific verification (FSV) - An alternative VV&T strategy for high reliability nuclear software systems.** Miller, L.A. (Science Applications International Corp., McLean, VA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The author puts forth an argument that digital instrumentation and control systems can be safely applied in the nuclear industry, but it will require changes to the way software for such systems is developed and tested. He argues for a fault-specific verification procedure to be applied to software development. This plan includes enumerating and classifying all software faults at all levels of the product development, over the whole development process. While collecting this data, develop and validate different methods for software verification, validation and testing, and apply them against all the detected faults. Force all of this development toward an automated product for doing this testing. Continue to develop, expand, test, and share these testing methods across a wide array of software products.

5946 (NUREG/CP–0136, pp. 267-274) **Certification of software for reuse in safety-critical applications.** Scheper, C.O. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

This paper describes a process for certifying software for reuse in safety-critical applications. This process is based on a two-tiered hierarchy of certification levels. The first, or Primary, level specifies evaluation objectives commensurate with assurance demands of increasing levels of criticality; i.e., it provides graded requirements for assurance evaluation based on criticality. The second, or Secondary, level specifies increasing levels of confidence that the certification process has met the evaluation objectives of the Primary level. It provides graded requirements for the rigor and breadth of the certification techniques needed to achieve the evaluation objectives given particular component and system characteristics. The structure of this certification process was designed to adapt to the certification requirements of multiple domains. It is based on a framework of evaluation techniques and tools that are common across all domains (and all certification levels). The selection and use of the techniques and tools to accomplish the evaluation objectives specific to each of the certification levels are managed by certification policies that are specific to a domain. The levels to which reusable components are certified are common across all domains, but the target certification level for a component is selected based on the derivation of domain-specific certification requirements.

5947 (NUREG/CP–0136, pp. 275-304) **Application of workshop to NRC activities.** Knight, J. (Univ. of Virginia, Charlottesville, VA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar

1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

The final workshop session was a panel presentation followed by an open question and discussion period. This panel contained a mix of academic and industry experts discussing the risks of safety-critical digital technology, especially the use of safety-critical software within these systems. The experts were asked to address these four questions: (1) Are the proper issues being addressed? (2) What other issues need to be addressed? (3) Are proposed NRC regulatory positions complete and correct? (4) What are the considerations for further research?

5948 (NUREG/CP–0136, pp. 305-307) **NUSMG Presentation: Nuclear utilities software management group.** Glidden, W. (Duquesne Light Company, Birdsboro, PA (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

At the close of the meeting, an opportunity was given for short position papers to be presented. Mr. Robert Mullens presented a paper written by Mr. Wayne Glidden (Duquesne Light Company) on behalf of the Nuclear Utilities Software Management Group (NUSMG). NUSMG was organized in 1989 by several utilities with the objective of providing a formal organization which would: acquire and exchange information on the regulation, processes, and programs used to establish and maintain control over software configuration and quality; assist the membership in the implementation of quality assurance programs and procedures which reflect these requirements.

5949 (NUREG/CP–0136, pp. 309-313) **NRC closing remarks.** Coffman, F. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; National Inst. of Standards and Technology, Gaithersburg, MD (United States). Mar 1994. (NIST-SP–500-216; CONF-9309161–: Digital systems reliability and nuclear safety workshop, Rockville, MD (United States), 13-14 Sep 1993). In *Proceedings of the Digital Systems Reliability and Nuclear Safety Workshop.* 368p. Source: OSTI; NTIS; INIS.

This section contains the edited transcript of the NRC closing remarks made by Mr. Franklin Coffman (Chief, Human Factors Branch, Office of Nuclear Regulatory Research) and Dr. Cecil Thomas (Deputy Director, Division of Reactor Controls and Human Factors, Office of Nuclear Reactor Regulation). This editing consisted of minimal editing to correct grammar and remove extraneous references to microphone volume, etc.

5950 (NUREG/CP–0139) **Transactions of the twenty-second water reactor safety information meeting.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research. Oct 1994. 129p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). (CONF-9410216–: 22. transactions of the water reactor safety information meeting, Bethesda, MD (United States), 24-26 Oct 1994). Source: OSTI; NTIS; INIS; GPO.

This report contains summaries of papers on reactor safety research to be presented at the 22nd Water Reactor Safety Information Meeting at the Bethesda Marriott Hotel, Bethesda, Maryland, October 24–26, 1994. The summaries briefly describe the programs and results of nuclear safety research sponsored by the Office of Nuclear Regulatory Research, US NRC. Summaries of invited papers concerning nuclear safety issues from US government laboratories, the electric utilities, the nuclear industry, and from foreign governments and industry are also included. The summaries have been compiled in one report to provide a basis for meaningful discussion and information exchange during the course of the meeting and are given in the order of their presentation in each session. Individual papers have been cataloged separately.

5951 (NUREG/CR–5247-Vol.1-Rev.2) **RASCAL Version 2.1, user's guide.** Sjoreen, A.L. (Oak Ridge National Lab., TN (United States)); Athey, G.F.; Ramsdell, J.V.; McKenna, T. Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data; Oak Ridge National Lab., TN (United States). Dec 1994. 190p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. (ORNL–6820/V1/R2). Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO; INIS.

The Radiological Assessment System for Consequence AnaLysis, Version 2.1 (RASCAL 2.1) has been developed for use during response to radiological emergencies. The system supplements assessments based on plant conditions and quick estimates based on hand-calculational methods. The model is designed to provide a comparison to EPA Protective Action Guidance and thresholds for acute health effects. RASCAL will be used by NRC personnel who report to the site of a nuclear accident to conduct an independent evaluation of dose and consequence projections and for training and drills. The model was developed to allow consideration of the dominant aspects of source term, transport, dose, and consequences. The model is a DOS application that can be run under Windows, and the results can be displayed as text or graphics. Revisions to RASCAL 2.0 have required the release of this new version of the system. Three new source term calculations have been added to ST-DOSE in RASCAL 2.1. They are (1) a source term based on the reactor containment monitor reading, (2) a source term for a spent fuel pool accident, and (3) an isotopic concentration source term. The tabular output of ST-DOSE and FM-DOSE have been changed to include EPA PAGS. Field Measurements to Dose (FM-DOSE) calculations have been modified to include consideration of the effect of delay for re-entry on first-year and second-year dose, to incorporate a variable resuspension rate, and to compute a factor used to estimate first-year dose from R/hr measurements on the ground. Also, RASCAL 2.1 supports the saving of cases for later display or modification and the use of a mouse for user input. References to the technical details are included. A RASCAL 2.1 workbook is available.

5952 (NUREG/CR–5591-Vol.2-No.1) **Heavy-Section Steel Irradiation Program. Volume 2, No. 1: Semiannual progress report, October 1990–March 1991.** Corwin, W.R. (Oak Ridge National Lab., TN (United States)). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering; Oak Ridge National Lab., TN (United States). Jul 1994. 36p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC05-84OR21400. (ORNL/TM–11568-Vol.2-No.1). Source: OSTI; NTIS; INIS; GPO.

Maintaining the integrity of the reactor pressure vessel (RPV) in a light-water-cooled nuclear power plant is crucial in preventing and controlling severe accidents that have the potential for major contamination release. The RPV is the only key safety-related component of the plant for which a duplicate or redundant backup system does not exist. It is therefore imperative to understand and be able to predict the capabilities and limitations of the integrity inherent in the RPV. For this reason, the Heavy-Section Steel Irradiation (HSSI) Program has been established with its primary goal to provide a thorough, quantitative assessment of the effects of neutron irradiation on the material behavior, and in particular the fracture toughness properties, of typical pressure-vessel steels as they relate to light-water reactor pressure-vessel integrity. The HSSI Program is arranged into nine tasks: (1) program management, (2) K_{Ic} curve shift in high-copper welds, (3) K_{Ia} curve shift in high-copper welds, (4) irradiation effects on cladding, (5) K_{Ic} and K_{Ia} curve shifts in low upper-shelf (LUS) weld, (6) irradiation effects in a commercial LUS weld, (7) microstructural analysis of irradiation, (8) in-service aged material evaluations, and (9) correlation monitor materials. During this period, additional analyses on the effects of precleavage stable ductile tearing on the toughness of high-copper welds 72W and 73W demonstrated that the size effects observed in the transition region are not due to substantial differences in ductile tearing behavior. Possible modifications to irradiated duplex crack-arrest specimens were examined to increase the likelihood of their successful testing. Characterization of a second batch of 72W and 73W welds was begun and results of the Charpy V-notch testing is provided. A review of literature on the annealing response of reactor pressure vessel steels was initiated.

5953 (NUREG/CR–6116-Vol.3) **Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE), Version 5.0: Integrated Reliability and Risk Analysis System (IRRAS) tutorial manual. Volume 3.** VanHorn, R.L. (EG and G Idaho, Inc., Idaho Falls, ID (United States)); Russell, K.D.; Skinner, N.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; EG and G Idaho, Inc., Idaho Falls, ID (United States). Jul 1994. 184p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC07-76ID01570. (EGG–2716-Vol.3). Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; INIS; GPO.

One copy to Berta Perez (ESTSC).

The Systems Analysis Programs for Hands-on Integrated Reliability Evaluations (SAPHIRE) refers to a set of several microcomputer programs that were developed to create and analyze probabilistic risk assessments (PRAs), primarily for nuclear power plants. This volume is the tutorial manual for the Integrated Reliability and Risk Analysis System (IRRAS) Version 5.0, a state-of-the-art, microcomputer-based probabilistic risk assessment (PRA) model development and analysis tool to address key nuclear plant safety issues. IRRAS is an integrated software tool that gives the user the ability to create and analyze fault trees and accident sequences using a microcomputer. A series of lessons is provided that guides the user through basic steps common to most analyses performed with IRRAS. The tutorial is divided into two major sections: basic and additional features. The basic section contains lessons that lead the student through development of a very simple problem in IRRAS, highlighting the program's most basic features. The additional features section contains lessons that expand on basic analysis features of IRRAS 5.0.

5954 (NUREG/CR–6144-Vol.2-Pt.3A) **Evaluation of potential severe accidents during low power and shutdown operations at Surry, Unit 1: Analysis of core damage frequency from internal events during mid-loop operations, Appendices E (Sections E.1–E.8). Volume 2, Part 3A.** Chu, T.L. (Brookhaven National Lab., Upton, NY (United States)); Musicki, Z.; Kohut, P. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Safety Issue Resolution; Brookhaven National Lab., Upton, NY (United States). Jun 1994. 557p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC02-76CH00016. (BNL-NUREG–52399-Vol.2-Pt.3A). Source: OSTI; NTIS; INIS; GPO.

During 1989, the Nuclear Regulatory Commission (NRC) initiated an extensive program to carefully examine the potential risks during low power and shutdown operations. The program includes two parallel projects being performed by Brookhaven National Laboratory (BNL) and Sandia National Laboratories (SNL). Two plants, Surry (pressurized water reactor) and Grand Gulf (boiling water reactor), were selected as the plants to be studied. The objectives of the program are to assess the risks of severe accidents initiated during plant operational states other than full power operation and to compare the estimated core damage frequencies, important accident sequences and other qualitative and quantitative results with those accidents initiated during full power operation as assessed in NUREG-1150. The objective of this report is to document the approach utilized in the Surry plant and discuss the results obtained. A parallel report for the Grand Gulf plant is prepared by SNL. This study shows that the core-damage frequency during mid-loop operation at the Surry plant is comparable to that of power operation. The authors recognize that there is very large uncertainty in the human error probabilities in this study. This study identified that only a few procedures are available for mitigating accidents that may occur during shutdown. Procedures written specifically for shutdown accidents would be useful.

5955 (NUREG/CR–6180) **Hydrogen Mixing Studies (HMS), user's manual.** Lam, K.L.; Wilson, T.L.; Travis, J.R. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; Los Alamos National Lab., NM (United States). Dec 1994. 119p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-36. (LA–12741-M). Source: OSTI; NTIS; GPO; INIS.

Hydrogen Mixing Studies (HMS) is a best-estimate analysis tool for predicting the transport, mixing, and combustion of hydrogen and other gases in nuclear reactor containments and other facilities. It can model geometrically complex facilities having multiple compartments and internal structures. The code can simulate the effects of steam condensation, heat transfer to walls and internal structures, chemical kinetics, and fluid turbulence. The gas mixture may consist of components included in a built-in library of 20 species. HMS is a finite-volume computer code that solves the time-dependent, three-dimensional (3D) compressible Navier Stokes equations. Both Cartesian and cylindrical coordinate systems are available. Transport equations for the fluid internal energy and for gas species densities are also solved. HMS was originally developed to run on Cray-type supercomputers with vector-processing units that greatly improve the computational speed, especially for large, complex problems. Recently the code has been converted to run on Sun workstations. Both the Cray and Sun versions have the same built-in graphics capabilities that allow 1D, 2D, 3D, and time-history plots of all solution variables. Other code features include a restart capability and flexible definitions of initial and time-dependent boundary conditions. This manual describes how to use the code. It explains how to set up the model geometry, define walls and obstacles, and specify gas species and material properties. Definitions of initial and boundary conditions are also described. The manual also describes various physical model and numerical procedure options, as well as how to turn them on. The reader also learns how to specify different outputs, especially graphical display of solution variables. Finally sample problems are included to illustrate some applications of the code. An input deck that illustrates the minimum required data to run HMS is given at the end of this manual.

5956 (NUREG/CR–6190-Vol.1-Rev.1) **Protection against malevolent use of vehicles at nuclear power plants: Vehicle barrier system siting guidance for blast protection.** Nebuda, D.T. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; Corps of Engineers, Omaha, NE (United States). Dec 1994. 12p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This manual provides guidance for determining the minimum safe standoff distance between vital safety related equipment and the design basis vehicle bomb threat adopted by the US Nuclear Regulatory Commission. Vital safety related equipment should survive the design basis vehicle bomb attack when the minimum safe standoff distance is provided. Guidance is provided for exposed vital safety related equipment and for equipment housed within vital area barriers.

5957 (NUREG/CR–6190-Vol.2-Rev.1) **Protection against malevolent use of vehicles at nuclear power plants.** Nebuda, D.T. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Reactor Regulation; Corps of Engineers, Omaha, NE (United States). Dec 1994. 33p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This manual provides a simplified procedure for selecting land vehicle barriers that will stop the design basis vehicle threat adopted by the US Nuclear Regulatory Commission. Proper selection and construction of vehicle barriers should prevent intrusion of the design basis vehicle. In addition, vital safety related equipment should survive a design basis vehicle bomb attack when vehicle barriers are properly selected, sites, and constructed. This manual addresses passive vehicle barriers, active vehicle barriers, and site design features that can be used to reduce vehicle impact velocity.

5958 (NUREG/CR–6278) **Survey of industry methods for producing highly reliable software.** Lawrence, J.D. (Lawrence Livermore National Lab., CA (United States)); Persons, W.L. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Reactor Controls and Human Factors; Lawrence Livermore National Lab., CA (United States). Nov 1994. 38p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract W-7405-ENG-48. (UCRL-ID–117524). Source: OSTI; NTIS; GPO; INIS.

The Nuclear Reactor Regulation Office of the US Nuclear Regulatory Commission is charged with assessing the safety of new instrument and control designs for nuclear power plants which may use computer-based reactor protection systems. Lawrence Livermore National Laboratory has evaluated the latest techniques in software reliability for measurement, estimation, error detection, and prediction that can be used during the software life cycle as a means of risk assessment for reactor protection systems. One aspect of this task has been a survey of the software industry to collect information to help identify the design factors used to improve the reliability and safety of software. The intent was to discover what practices really work in industry and what design factors are used by industry to achieve highly reliable software. The results of the survey are documented in this report. Three companies participated in the survey: Computer Sciences Corporation, International Business Machines (Federal Systems Company), and TRW. Discussions were also held with NASA Software Engineering Lab/University of Maryland/CSC, and the AIAA Software Reliability Project.

5959 (SAND–93-2686C) **Early results from an experimental program to determine the behavior of containment piping penetration bellows subjected to severe accident conditions.** Lambert, L.D.; Parks, M.B. Sandia National Labs., Albuquerque, NM (United States). [1994]. 22p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941011–3: 3. international conference on containment design and operation, Toronto (Canada), 19-21 Oct 1994). Order Number DE94019178. Source: OSTI; NTIS; INIS; GPO Dep.

Containment piping penetration bellows are an integral part of the pressure boundary in steel containments in the United States (US). Their purpose is to minimize loading on the containment shell caused by differential movement between the piping and the containment. This differential movement is typically caused by thermal gradients generated during startup and shutdown of the reactor, but can be caused by earthquake, a loss-of-coolant accident (LOCA), or "severe" accidents. In the event of a severe accident, the bellows would be subjected to pressure, temperature, and deflection well beyond the design basis. Most bellows are installed such that they would be subjected to elevated internal pressure, elevated temperature, axial compression, and lateral deflection during a severe accident. A few bellows would be subjected to external pressure and axial elongation, as well as elevated temperature and lateral deflection. The purpose of this experimental program is to examine the potential for leakage of containment bellows during a severe accident. The test series subjects bellows to various levels and combinations of internal pressure, elevated temperature, axial compression or elongation, and lateral deformation. The experiments are being conducted in two parts. For Part 1, all bellows specimens are tested in "like-new" condition, without regard for the possible degrading effect of corrosion that has been observed in some containment piping bellows in the US Part I testing, which included 13 bellows tests, has been completed. The second part of the experimental program, in which bellows are subjected to simulated corrosive environments prior to testing, has just just begun. The Part I experiments have shown that bellows in "like-new" condition can withstand elevated temperatures and pressures along with large deformations before leaking. In most cases, the like-new bellows were fully compressed without developing any leakage.

5960 (SAND–93-2698C) **Analyses of a steel containment vessel with an outer contact structure under severe internal overpressurization conditions.** Porter, V.L. Sandia National Labs., Albuquerque, NM (United States). [1993]. 20p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941011–5: 3. international conference on containment design and operation, Toronto (Canada), 19-21 Oct 1994). Order Number DE94019179. Source: OSTI; NTIS; INIS; GPO Dep.

Many Mark-I and Mark-II BWR plants are designed with a steel vessel as the primary containment. Typically, the steel containment vessel (SCV) is enclosed within a reinforced concrete shield building with only a small gap (50–90mm) separating the two structures. This paper describes finite element analyses performed to evaluate the effects of contact and friction between a steel containment vessel and an outer contact structure when the containment vessel is subjected to large internal pressures. These computations were motivated by a joint program on containment integrity involving the Nuclear Power Engineering Corporation (NUPEC) of Japan, the US Nuclear Regulatory Commission (NRC), and Sandia National Laboratories for testing model containments.

5961 (SAND–94-2157) **A comparison of world-wide uses of severe reactor accident source terms.** Ang, M.L. (NNC Ltd., Knutsford (United Kingdom)); Frid, W.; Kersting, E.J.; Friederichs, H.G.; Lee, R.Y.; Meyer-Heine, A.; Powers, D.A. Sandia National Labs., Albuquerque, NM (United States). Sep 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95001418. Source: OSTI; NTIS; INIS; GPO Dep.

The definitions of source terms to reactor containments and source terms to the environment are discussed. A comparison is made between the TID-14844 example source term and the alternative source term described in NUREG-1465. Comparisons of these source terms to the containments and those used in France, Germany, Japan, Sweden, and the United Kingdom are made. Source terms to the environment calculated in NUREG-1500 and WASH-1400 are discussed. Again, these source terms are compared to those now being used in France, Germany, Japan, Sweden, and the United Kingdom. It is concluded that source terms to the containment suggested in NUREG-1465 are not greatly more conservative than those used in other countries. Technical bases for the source terms are similar. The regulatory use of the current understanding of radionuclide behavior varies among countries.

5962 (SAND–94-2166) **MELCOR 1.8.2 assessment: Aerosol experiments ABCOVE AB5, AB6, AB7, and LACE LA2.** Souto, F.J. (Univ. of New Mexico, Albuquerque, NM (United States). Dept. of Chemical and Nuclear Engineering); Haskin, F.E.; Kmetyk, L.N. Sandia National Labs., Albuquerque, NM (United States). Oct 1994. 223p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004271. Source: OSTI; NTIS; INIS; GPO Dep.

The MELCOR computer code has been used to model four of the large-scale aerosol behavior experiments conducted in the Containment System Test Facility (CSTF) vessel. Tests AB5, AB6 and AB7 of the ABCOVE program simulate the dry aerosol conditions during a hypothetical severe accident in an LMFBR. Test LA2 of the LACE program simulates aerosol behavior in a condensing steam environment during a postulated severe accident in an LWR with failure to isolate the containment. The comparison of code results to experimental data show that MELCOR is able to correctly predict most of the thermal-hydraulic results in the four tests. MELCOR predicts reasonably well the dry aerosol behavior of the ABCOVE tests, but significant disagreements are found in the aerosol behavior modelling for the LA2 experiment. These results tend to support some of the concerns about the MELCOR modelling of steam condensation onto aerosols expressed in previous works. During these analyses, a limitation in the MELCOR input was detected for the specification of the aerosol parameters for more than one component. A Latin Hypercube Sampling (LHS) sensitivity study of the aerosol dynamic constants is presented for test AB6. The study shows the importance of the aerosol shape factors in the aerosol deposition behavior, and reveals that MELCOR input/output processing is highly labor intensive for uncertainty and sensitivity analyses based on LHS.

5963 (WAPD-T–3038) **Evaluation of the RELAP5/MOD3 multidimensional component model.** Tomlinson, E.T.; Rens, T.E.; Coffield, R.D. Westinghouse Electric Corp., West Mifflin, PA (United States). Bettis Atomic Power Lab. [1994]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-9408140–1: 1994 RELAP-5 internal users seminar, Baltimore, MD (United States), 29 Aug - 1 sep 1994). Order Number DE94017545. Source: OSTI; NTIS; INIS; GPO Dep.

Accurate plenum predictions, which are directly related to the mixing models used, are an important plant modeling consideration because of the consequential impact on basic transient performance calculations for the integrated system. The effect of plenum is a time shift between inlet and outlet temperature changes to the

particular volume. Perfect mixing, where the total volume interacts instantaneously with the total inlet flow, does not occur because of effects such as inlet/outlet nozzle jetting, flow stratification, nested vortices within the volume and the general three-dimensional velocity distribution of the flow field. The time lag which exists between the inlet and outlet flows impacts the predicted rate of temperature change experienced by various plant system components and this impacts local component analyses which are affected by the rate of temperature change. This study includes a comparison of two-dimensional plenum mixing predictions using CFD-FLOW3D, RELAP5/MOD3 and perfect mixing models. Three different geometries (flat, square and tall) are assessed for scalar transport times using a wide range of inlet velocity and isothermal conditions. In addition, the three geometries were evaluated for low flow conditions with the inlet flow experiencing a large step temperature decrease. A major conclusion from this study is that the RELAP5/MOD3 multidimensional component model appears to be adequately predicting plenum mixing for a wide range of thermal-hydraulic conditions representative of plant transients.

24 POWER TRANSMISSION AND DISTRIBUTION

Refer also to citation(s) 6087

5964 (ANL/ET/CP–83629) **Design and production of efficient current leads for 1500-A, 50-Hz service in a 77-4 K temperature gradient.** Balachandran, U. (and others); Youngdahl, C.A.; Lanagan, M.T. Argonne National Lab., IL (United States). Energy Technology Div. Oct 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-941176–1: 7. international symposium on superconductivity, Kita Kiyushu (Japan), 8-11 Nov 1994). Order Number DE95004121. Source: OSTI; NTIS; GPO Dep.

Two arrays of BSCCO 2223 bars were designed and produced for use in current leads for a power utility fault-current limiter operating at 4 K. Each conduction-cooled array, consisting of four parallel bars arranged within a 100-mm-diameter boundary, delivered 1,500 A peak, 50-Hz AC through a 77-4 K temperature gradient while dissipating < 0.2 W. The sinter-forged bars displayed DC critical current densities of 950–1,300 A/cm^2 at 77 K and > 5,000 A/cm^2 at 4 K. Magnetic field sensitivity was relatively low. Thermal conductivity tests showed values higher than literature values for polycrystalline BSCCO 2223 made by other processes.

2401 Power Systems

5965 (LA-UR–94-3655) **Anisotropic high temperature superconductors as variable resistors and switches.** Boenig, H.J.; Daugherty, M.A.; Fleshler, S.; Maley, M.P.; Mueller, F.M.; Prenger, F.C.; Coulter, J.Y. Los Alamos National Lab., NM (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941013–15: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95003710. Source: OSTI; NTIS; GPO Dep.

Several anisotropic high temperature superconductors show critical current densities which are strongly dependent on the direction of an applied external magnetic field. The resistance of a sample can change by several orders of magnitude by applying a magnetic field. The potential for using the field dependent variable resistor or switch for applications in power systems is evaluated. Test results with small samples are presented. The requirements for large scale applications are outlined. The magnetic field triggering requirement, the frequency response of the device, use in 60 Hz ac circuits and heat transfer consideration are investigated. Several application examples are discussed. Use of variable resistor as a fault current limiter, as a switching element in rectifier circuitry and as an improved dump resistor for a superconducting magnet is presented.

2402 Power System Networks, Transmission and Distribution

5966 (TVA/RG/EQS–93/1) **Tennessee Valley Authority Eagle Bend 161-kV delivery point environmental assessment.** Tennessee Valley Authority, Knoxville, TN (United States). 5 Feb 1993. 28p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003302. Source: OSTI; NTIS.

Eagle Bend is an area located in a bend of the Clinch River about one mile southeast of Clinton, Tennessee, in Anderson County. This area, including an industrial park, is supplied electric power by the Clinton Utilities Board (UB) through its 69-kV system, which is in turn supplied by TVA over a 69-kV transmission line from Norris Hydro Plant. Studies of the power supply in the area indicate that there will likely be significant load growth both in the Clinton area in general and the industrial park in particular. Studies further show that if this new load is supplied at 69-kV, the TVA transformer at Norris Hydro which supplies this load will be overloaded by the summer of 1993 and no feasible alternate source which would maintain the quality and reliability of the power delivered to the Clinton system exists to accept this load. Clinton UB also needs to transfer load from its Clinton substation in the same time period to prevent overloading. Additional studies and consultation between TVA and Clinton UB have indicated that the best solution to this problem is to supply this load at 161-kV at a new delivery point for Clinton UB. This would require the construction of a new 161/13-kV substation by Clinton UB and the construction by TVA of a new 161-kV transmission line to connect this substation to the existing TVA 161-kV transmission system.

2404 Health and Safety

Refer also to citation(s) 5967, 6266

2405 Environmental Aspects

Refer also to citation(s) 5966

5967 (PNL–10110) **Proposed framework for the Western Area Power Administration Environmental Risk Management Program.** Glantz, C.S. (Pacific Northwest Lab., Richland, WA (United States)); DiMassa, F.V.; Pelto, P.J.; Brothers, A.J.; Roybal, A.L. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 120p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95004713. Source: OSTI; NTIS; GPO Dep.

The Western Area Power Administration (Western) views environmental protection and compliance as a top priority as it manages the construction, operation, and maintenance of its vast network of transmission lines, substations, and other facilities. A recent Department of Energy audit of Western's environmental management activities recommends that Western adopt a formal environmental risk program. To accomplish this goal, Western, in conjunction with Pacific Northwest Laboratory, is in the process of developing a centrally coordinated environmental risk program. This report presents the results of this design effort, and indicates the direction in which Western's environmental risk program is heading. Western's environmental risk program will consist of three main components: risk communication, risk assessment, and risk management/decision making. Risk communication is defined as an exchange of information on the potential for threats to human health, public safety, or the environment. This information exchange provides a mechanism for public involvement, and also for the participation in the risk assessment and management process by diverse groups or offices within Western. The objective of risk assessment is to evaluate and rank the relative magnitude of risks associated with specific environmental issues that are facing Western. The evaluation and ranking is based on the best available scientific information and judgment and serves as input to the risk management process. Risk management takes risk information and combines it with relevant non-risk factors (e.g., legal mandates, public opinion, costs) to generate risk management options. A risk management tool, such as decision analysis, can be used to help make risk management choices.

2406 Legislation and Regulations

5968 (DOE/EIS–0204) **Hermiston Generating Project: Administrator's record of decision on PacifiCorp request for transmission service.** USDOE Bonneville Power Administration, Portland, OR (United States). Aug 1994. 9p. Sponsored by USDOE, Washington, DC (United States). (DOE/BP–2451). Order Number DE95002673. Source: OSTI; NTIS; GPO Dep.

The Hermiston Generating Project is a proposed gas-fired cogeneration power plant near Hermiston, Oregon. The plant would supply steam to the Lamb-Weston potato processing facility on an adjacent site, and electricity generated at the plant would be sold to PacifiCorp. The plant would add 464 megawatts of capacity to the Northwest power grid, annually generating approximately 3.86 million megawatthours of electricity. In order to respond to PacifiCorp's request for transmission, BPA conducted an analysis of existing system facilities, which showed that with some upgrades, the system is capable of accommodating the additional transmission. The Final EIS documented PacifiCorp's need for intra-regional transmission service, and BPA's responsibility to provide that service in accordance with the requirements of the Transmission System Act, and the EPA '92. The Final EIS found there to be environmental impacts from the construction and operation of the plant. The Hermiston Generating Project includes features designed to reduce the environmental impacts. No evidence emerged to suggest that the project is controversial. This Record of Decision documents BPA's decision to proceed with a transmission contract with PacifiCorp in order to provide transmission services for the power generated by the Hermiston Generating Project. This contract will maximize power system efficiencies and coordination between PacifiCorp and BPA, and assist BPA in achieving positive net revenues by generating approximately $5,067,000 annually.

2407 Economic, Industrial, and Business Aspects

Refer also to citation(s) 6039, 7066

5969 (SP–94-55) **Information security of remote-reading energy meters.** Jacobson, J. Swedish National Testing and Research Inst., Boraas (Sweden). 1994. 27p. (In Swedish). Order Number DE95723983. Source: OSTI; NTIS; INIS.

This report presents basic concepts within the field of IT security. The ITSEC security and the ITSEM methods given by the European Community are used as a base. The EC INFOSEC research programme has included the project 'PER DOMUM' which focuses on remote reading of energy meters. The project is a co-operation between TACS (U.K.), GPP (Germany), CESI (Italy) and ENEL (Italy). SP has during the spring and summer of 1994 participated in the concluding of the project. Threats, security functions and security mechanisms are given for remote reading of energy meters. All of the listed functions and mechanisms do not origin from the 'PER DOMUM' project, but are the experiences of SP. The security evaluation is explained in two ways. One description of the required by ITSEM is given. Another description is given of which deliverables are required to perform the evaluation.

25 ENERGY STORAGE

2506 Thermal

5970 (DTH-IMSOR-TR–1993-12) **Stochastic heat storage problem - solved by the progressive hedging algorithm.** Palsson, O.P.; Ravn, H.F. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1993. 33p. Contract ENS-1323/91-0010. Order Number DE95723832. Source: OSTI; NTIS.

EFP-91.

In the present study a problem concerning operation of a heat storage tank in connection with a combined heat and power (CHP) plant is considered. The heat storage is used to supply the district heating system when the CHP plant is producing electric power alone and also to optimally redistribute over time the required heat production. Stochasticity is assumed attached to the future power production and it is assumed that accurate predictions of the future heat consumption are available. A receding horizon idea is used. The problem is solved by the Progressive Hedging Algorithm (PHA), a recently developed method to deal with multi-period optimization problems under uncertainty. The application of the method is explained in detail. (au) (10 refs.)

2508 Chemical

Refer also to citation(s) 5516

2509 Batteries

Refer also to citation(s) 5521

29 ENERGY PLANNING AND POLICY

5971 (CONF-9403188–) **U.S.-Japan Energy Conference/Maui Meeting.** Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

The U.S.-Japan Energy Conference/Maui Meeting was held in the Maui island, Hawaii during March 7-9, 1994. The theme in Session 1 is 'effects of the Asian situation on the world energy market', and a special lecture and reports/discussions were given. In Session 2, reports/discussions were made on the theme, 'the global environment and energy efficiency.' In Session 3, the theme was 'energy outlook,' and reports/discussions were made on the following: coal related issues, oil related issues, recent situation and future outlook pertaining to gas, the electric industry and its related issues in the U.S. and Japan, nuclear power related issues and the U.S.-Japan cooperation, etc. The U.S. made a report on foreign investment in Russia and technical cooperation. In conclusion, the two made their general comments.

5972 (CONF-9403188–, pp. 21-33) **Keynote report by special guest.** Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

A lecture at the Maui meeting of U.S.-Japan Energy Policy Consultations was delivered by Mr.Yoichi Funabashi, General Director in the U.S., Asahi Shimbun Publishing Company. The historical significance of Japan's diplomatic policy since the U.K.-Japan Alliance and the present situation in Japan, the U.S. and China were explained. As a present problem in Japan, it was pointed out that the votes of urban electors were not fully reflected in the number of parliamentary seats, and votes in agricultural and rural districts applied imbalanced pressure to Japanese politics, and negative pressure to politic parties insisting market liberation and with an international global view. In addition, since the Hosokawa administration, there has been power vacuum, political and financial power weakened, and the Ministry of Finance has filled the vacuum. According to his lecture, it was unclear who promoted regulation relaxation, and administration reforms in their true sense. The economic community should propose policy plans independently, and should have them reflected in decision making of the nation. Also it was important to maintain and strengthen the value of the U.S.-Japan alliance relation.

5973 (CONF-9403188–, pp. 34-49) **Economic development in Asia and subjects to be met.** Kano, E. Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

A report on the economic growth of Asian countries at the Maui meeting of U.S.-Japan Energy Policy Consultations was presented by Mr.Kano, the Industrial Bank of Japan, Ltd. Asian countries (NIEs, ASEAN, China) achieved economic growth of more than 7% on the average in 1993, and about 7% growth is expected for 1994. In recent years, Asian countries have developed themselves not only as suppliers of industrial products to European nations, the U.S. and Japan, but also have expanded their domestic consumer markets, deepening mutual dependent relation in direct investment and trade in Asia. In direct investment, Japan and NIEs countries are major direct investors in ASEAN countries and China. In trade, since 1988, intraregional exports including Japan have exceeded those to the U.S. In 1992, the proportion of Asian exports within the region was 42%, exceeding the proportion of Asian exports to the U.S. (24%). Asian countries are now improving infrastructures, mainly in transport, communication and electric power, aiming at continuous steady growth in the future.

5974 (ETDE/DE-mf–95733301) **East German energy sector in upheaval. Pt. 3.** Institut fuer Wirtschaftsforschung. Forschungsreihe, v. 4/93. Matthies, J.; Laschke, B.; Weisheimer, M. Institut fuer Wirtschaftsforschung Halle (IWH) (Germany). Jul 1993. 90p. (In German). Order Number DE95733301. Source: OSTI; NTIS (US Sales Only).

The following report provides a summarized view of the problem areas on which the Energy and Environment Department staff at IWH have been working recently. The themes reflect the current fundamental problems challenges and solutions in the transition from a planned to a market economy. They are as follows: 1. Forecast of electric power consumption in East German mining and processing plants until 2005. 2. Public funding of energy conservation and CO_2 reduction in domestic building -how efficient is it? 3. The East German energy supply in its new context. (orig./UA)

5975 (ETDE/DE-mf–95733301, pp. 71-90) **Changes in East German energy supply.** Weisheimer, M. Institut fuer Wirtschaftsforschung Halle (IWH) (Germany). Jul 1993. 90p. (In German). In *East German energy sector in upheaval. Pt. 3.* Order Number DE95733001. Source: OSTI; NTIS (US Sales Only).

The contribution aims at an overview of the transformed conditions for business activity in the energy sector. The firms face challenges in view of the present economic climate in Germany and Europe, the transition to privatisation and competition as well as the requirement to meet West German and Western european environmental standards. (orig.)

5976 (ETDE/DE-mf–95733349) **Power supply in the European Community. Facts and figures.** Czakainski, M.; Koerber, H. Bundesministerium fuer Wirtschaft, Bonn (Germany). Referat Oeffentlichkeitsarbeit. Jul 1993. 108p. (In German). Order Number DE95733349. Source: OSTI; NTIS (US Sales Only).

Following a few introductory comments on European integration the book gives a short overview of some important data concerning the EC. It then gives separate short statements for each of the 12 member states regarding energy resources, dependency on imports, primary energy and electricity consumption, and energy policy. The next section gives an overview of the roles played by individual energy sources in the power supply of the EC. In concluding the book comments on the issue of energy and environment protection and on the future prospects for the European power supply. The appendix gives the most important figures characterising the development from 1980 to 1991. (UA)

5977 (ETDE/DE-mf–95733375) **Industrial and structural policy for the North-Rhine Westphalia area.** Ministerium fuer Wirtschaft, Mittelstand und Technologie des Landes Nordrhein-Westfalen, Duesseldorf (Germany). Oct 1993. 96p. (In German). Order Number DE95733375. Source: OSTI; NTIS (US Sales Only).

The current publication contains an outline illustration of a future-orientated economic and structural policy for North-Rhine Westphalia, along with four speeches on local politics, external economics, technology- and energy policies. These set out the basic positions of the North-Rhine Westphalia Minister for Economic Affairs, Business and Technology. (UA)

5978 (FFU–93-3) **Energy policy in Thailand. On the prospects of energy efficiency strategies in a threshold country.** Boensch, W. Freie Univ. Berlin (Germany). Forschungsstelle fuer Umweltpolitik. 1993. 127p. (In German). Order Number DE95733354. Source: OSTI; NTIS (US Sales Only).

After an explanation of the workings of economy strategies in conditions where priority is given to industrialisation and growth, the situation of the individual energy sectors in Thailand is described. A separate chapter is dedicated to the electricity sector, dealing with the development of consumption and the supply-side and demand-side economy measures. The willingness of individual political protagonists and the enactment of energy economy packages have of themselves not been able to bring about a fundamental change to energy policy. Energy economy policies often fail because of the lack of clearly defined responsibilities and the clash of interests within the arena of energy policy. (UA)

2901 Energy Analysis and Modeling

5979 (ETDE/DE-mf–95733287) **Energy report 1991 of the city of Frankfurt am Main.** Linder, M. Stadt Frankfurt am Main (Germany). Hochbauamt. 1993. 70p. (In German). Order Number DE95733287. Source: OSTI; NTIS (US Sales Only).

In 1991 considerable progress has been made in the area of energy conservation and thus also of climate protection in municipal buildings of the city of Frankfurt on the Main. In the first chapter of this report the consumption development in 1991 in city properties is described. Further chapters deal with low-entropy houses, the conversion of heating systems, water conservation and energy management. (UA)

2902 Economics and Sociology

Refer also to citation(s) 5015, 5111, 5989, 5997, 6017, 6069, 6125

5980 (CONF-9403188–, pp. 105-112) **Problem of global environment and improvement of energy efficiency.** Fujime, K. (The Institute of Energy Economics, Tokyo (Japan)); Matsuo, N. Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At the Maui meeting of U.S.-Japan Energy Policy Consultations, a report on the problem of global environment and improvement of energy efficiency was delivered by Mr.Fujime and Matsuo, the Institute of Energy Economics. By economic growth and increasing energy consumption, load on environment is increasing, but the key to solve this dilemma is to reduce energy consumption per production. Though Japan's GNP continued to increase in the oil shock period from 1973-1986, primary energy consumption and CO2 emission hardly increased. Especially in steel and chemical industries which consume abundant energy, energy consumption per mining and manufacturing industry index decreased by 50% at the maximum. This indicates the rapid improvement of energy consumption efficiency. If energy consumption efficiency of Japan's level is achieved in the former communist bloc and developing countries, the amount of CO2 emission will be halved, and the effect is believed extremely large. 8 figs., 2 tabs.

5981 (CONF-9403188–, pp. 185-188) **Foreign countries' investment to and technical cooperation with Russia.** Rossiter, W. Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy Consultation, Mr. W.D.Rossiter from Conoco, Ltd. lectured on investment to Russia from foreign countries. The initiative in creating the policy proposal to Russia and Ukraine by Atlantic Council is very important. However, the possibility of the initiative to really have the effects on the

policies of the Russian Government may be low. It is quite uncertain that the Russian Government may pay serious attention to these concepts for ten years to come. The only one thing possible for Russia may be to secure islands of 'success' here and there by around 2000. The current Russian economy does not seem to have any choice for improvement throughout the country. Criminal crimes are spreading to every section of Russian society. Policy discussions involve crimes. The Russian imperialism has survived. The military takes the top place as a return to backing Yeltsin. Remember that Russians are xenophobic by nature.

5982 (CRIE-Y–93008) **Analysis of regional economic differential in Japan.** Yamanaka, Y.; Baba, K. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1994. 51p. (In Japanese). Order Number DE95730182. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

The composition of regional economic differential was analyzed to elucidate the development mechanism of regional economy. That composition was to be grasped from the four following facts: the regional income differential enlarged in the 1980's. The main factor of income differential is the labor productivity differential. The income differential has been enlarging since a high working rate supporting the regional income started to break. Since 1975, the regional labor productivity differential has been enlarging in all the industries. The industries to which the enlargement of labor productivity differential was attributable in all industries were the manufacturing industry, wholesale and retail trade, and financial and insurance business. In those industries, the correlation of indirect department charge has been gradually heightening with the labor productivity, which is prescribed by the role division among regions. Mostly depending upon the final demand in the Kanto Region, the production in all regions strongly showed the foregoing trend in 1975 through 1985. The ability of connecting the final demand inside and outside the region with the production inside it is positively correlative with its labor productivity. 45 refs., 24 figs., 8 tabs.

5983 (CRIE-Y–93011) **Present state and problems of employee satisfaction. Organizational activation of electric utility management.** Ariu, T.; Maruyama, M.; Iuchi, M. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1994. 40p. (In Japanese). Order Number DE95730183. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

Aiming at organizational activation adapted to electric utility management, the satisfaction of employees who worked at main offices of electric utilities, on the basis of results of a questionnaire sent to general corporate employees was investigated. Employees thought that electric utility management was characterized by heaviness, seniority, long-range, plain, and growth-oriented nature. We again confirmed that electric utilities were positively engaged in the contribution to society as management activity and strategy. Under these corporate trends, employees intended to be generalists, rather than independent specialists. While they were comparatively satisfied with public welfare and human relationship at workplace, they were slightly dissatisfied with the methods of decision making and performance evaluation. As a result of the analysis of the satisfaction-importance relation and factors influencing satisfaction, important points in personnel systems for organizational activation were sorted out. It is concluded that communication between employers and employees is effective for electric utilities which place emphasis on their social nature. In this paper, examples of positive communication activity of well-known corporations in various field are also presented. 54 refs., 21 figs., 6 tabs.

5984 (DOE/EIA–0376(92)) **State energy price and expenditure report 1992.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. 1 Dec 1994. 294p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004173. Source: OSTI; NTIS; GPO; GPO Dep.

The State Energy Price and Expenditure Report (SEPER) presents energy price and expenditure estimates individually for the 50 States and the District of Columbia and in aggregate for the United States. The price and expenditure estimates are provided by energy source and economic sector and are published for the years 1970, 1980, and 1985 through 1992. Data for all years, 1970 through 1992, are available on personal computer diskettes.

5985 (DOE/EIA–0543(94/3Q)) **U.S. energy industry financial developments, 1994 third quarter.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1994. 17p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004665. Source: OSTI; NTIS; GPO; GPO Dep.

This report traces key financial trends in the U.S. energy industry for the third quarter of 1994. Financial data (only available for publicly-traded U.S. companies) are included in two broad groups–fossil fuel production and rate-regulated utilities. All financial data are taken from public sources such as energy industry corporate reports and press releases, energy trade publications, and The Wall Street Journal's Earnings Digest. Return on equity is calculated from data available from Standard and Poor's Compustat data service. Since several major petroleum companies disclose their income by lines of business and geographic area, these data are also presented in this report. Although the disaggregated income concept varies by company and is not strictly comparable to corporate income, relative movements in income by lines of business and geographic area are summarized as useful indicators of short-term changes in the underlying profitability of these operations. Each company is assigned to a particular functional activity based on segment revenue. Companies in each industry grouping include only the publicly-traded companies whose financial data were available in time for publication. To demonstrate the degree to which these industry groupings represent shares of industry activity, shares for the domestic industry segments were calculated for the companies included in this report against their respective total industry grouping. An effort is made to ensure that period-to-period comparisons reflect actual operating results.

5986 (INIS-mf–15072) **Saarbergwerke AG. Annual report 1992.** Saarbergwerke AG, Saarbruecken (Germany). 1993. 70p. (In German). Order Number DE95733251. Source: OSTI; NTIS (US Sales Only); INIS.

The business report contains informations about the position of the energy economics, the position of the Saarberg trust and the yearly balance. The activities in the field of energy comprise the production and scale of coal, the production of coke and electrical power and district heat. Furthermore it is reported about the trade of solid and liquid fuels, services in the engineering and environment technology and non-energy activities. (orig.)

5987 (WHC-SA–2209) **Calculating cost-training billback at WHC.** Gardner, P.R. Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-931188–5: 17. annual training resources and data exchange conference: integrating training requirements and expectations, Indianapolis, IN (United States), 15-17 Nov 1993). Order Number DE95003272. Source: OSTI; NTIS; INIS; GPO Dep.

Westinghouse Hanford Company, in an attempt to understand training costs and to find a make-or-buy tool for training, has constructed a Training Cost Estimator. Among the outputs of this Lotus program are projected numbers of instructor, managers, and secretarial staff, and cost per student ("tuition").

5988 (WHC-SA–2210) **The Instructor-Free Training Department.** Gardner, P.R. (Westinghouse Hanford Co., Richland, WA (United States)); Sanford, D.E. Westinghouse Hanford Co., Richland, WA (United States). Nov 1993. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-931188–4: 17. annual training resources and data exchange conference: integrating training requirements and expectations, Indianapolis, IN (United States), 15-17 Nov 1993). Order Number DE95003273. Source: OSTI; NTIS; GPO Dep.

Today's skills will be obsolete in the year 2000. That workforce will require a much higher degree of technical sophistication and adaptability. Enormous demands will be made of DOE contractor training departments even as federal deficit reduction actions increasingly restrict resources and as the emergence of electronic

performance support systems appear to diminish the need for training. True training will still be required but they must, and can, train better, faster, and cheaper. These goals are attainable by implementing the implications of performance-based training and by focusing on learning instead of on teaching. (Indeed, ability to learn efficiently and rapidly will be the premier talent in the next century.) Training Departments must dedicate themselves to changing performance, not to teaching classes. The best training department of the future will have no "instructors". Trainingforce 2000 will look and function much differently.

2903 Environment, Health, and Safety

Refer also to citation(s) 4904, 4989, 4993, 5183, 5185, 5221, 5980, 6013, 6018, 6036, 6052, 6053, 6056, 7082

5989 (CONF-9403188–, pp. 101-104) **Global environmental issues.** Malin, C. (Texaco Inc., (United States)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

A lecture on global environment and energy efficiency at the Maui meeting of U.S.-Japan Energy Policy Consultations was delivered by Mr.Maylin, vice president of Texaco. Today, there is considerable confusion in targets in coping with environmental problems, which move energy policy in the world. While we have reached a level where up to 97% of the pollutants from exhaust gas emitted from automobiles can be removed, further 1.5-2% reduction will require funds equal to funds used to reduce pollutants by 97%. The solution of the problem of 'soil pollution' will be technically feasible, although invested costs cannot be completely recovered easily. However, it seems difficult to cope with global scale climatic changes. It is unclear whether the problem of global warming is truly serious or a fabrication by environmentalists. The truth is believed to lie between extremes. While various policies are being promoted, the industrial world is to bear such expenses. It is believed that the industrial world has a right and an obligation to participate in the discussion of public policy.

5990 (DOE/EA–0958) **The proposed Institute for Micromanufacturing, Louisiana Tech University.** USDOE Chicago Operations Office, Argonne, IL (United States). Jul 1994. 31p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004412. Source: OSTI; NTIS; GPO Dep.

The Department of Energy (DOE) has prepared an Environmental Assessment (EA) DOE/EA-0958, evaluating the construction and equipping of two components of the proposed Institute for Micro-manufacturing at Louisiana Tech University (LTU), a proposed R and D facility to be located in Ruston, LA. and, the proposed installation of a beamline for micro-machining applications at the Center for Advanced Microstructures and Devices (CAMD) facility at Louisiana State University in Baton Rouge, LA. The objective of the proposed project is to focus on the applied, rather than basic research emphasizing the design and development, metrology, inspection and testing, and the assembly and production of micron and submicron structures and devices. Also, the objective of the beamline at CAMD would be the fundamental study of processing and analysis technologies, including x-ray lithography, which are important to microstructures fabrication and electronic device development. Based on the analysis in the EA, the DOE has determined that the proposed action does not constitute a major federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969 (NEPA). Therefore, the preparation of an Environmental Impact Statement is not required.

5991 (DOE/EA–1001) **Environmental assessment for commercialization of the Mound Plant.** Department of Energy, Washington, DC (United States). Div. of Electric Energy Systems. 26 Oct 1994. 98p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004415. Source: OSTI; NTIS; INIS; GPO Dep.

In November 1993 US DOE decided to phase out operations at the Mound Plant in Miamisburg, Ohio, with the goal of releasing the site for commercial use. The broad concept is to transform the plant into an advanced manufacturing center with the main focus on commercializing products and other technology. DOE proposes to lease portions of the Mound Plant to commercial enterprises. This Environmental Impact statement has a finding of no significant impact in reference to such action.

5992 (DOE/EH–231011-Rev.I/0194) **Federal Agency Hazardous Waste Compliance Docket (docket). Revision 1.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Environmental Guidance. Jan 1994. 4p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94016529. Source: OSTI; NTIS; GPO Dep.

The Federal Facilities Hazardous Waste Compliance Docket ("docket") identifies Federal facilities that may be contaminated with hazardous substances and that must be evaluated to determine if they pose a risk to public health or the environment The docket, required by Section 120(c) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), also provides a vehicle for making information about potentially contaminated facilities available to the public. Facilities listed on the docket must complete site assessments that provide the Environmental Protection Agency (EPA) with information needed to determine whether or not the facility should be included on he National Priorities List (NPL). This Information Brief, which revises the previous Federal Agency Hazardous Waste Compiliance Docket Information Brief, provides updated information on the docket listing process, the implications of listing, and facility status after listing.

5993 (DOE/EM–0202) **In Situ Remediation Integrated Program. In situ physical/chemical treatment technologies for remediation of contaminated sites: Applicability, developing status, and research needs.** Siegrist, R.L.; Gates, D.D.; West, O.R.; Liang, L.; Donaldson, T.L.; Webb, O.F.; Corder, S.L.; Dickerson, K.S. Oak Ridge National Lab., TN (United States). Jun 1994. 62p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003294. Source: OSTI; NTIS; INIS; GPO Dep.

The U.S. Department of Energy (DOE) In Situ Remediation Integrated Program (ISR IP) was established in June 1991 to facilitate the development and implementation of in situ remediation technologies for environmental restoration within the DOE complex. Within the ISR IP, four subareas of research have been identified: (1) in situ containment, (2) in situ physical/chemical treatment (ISPCT), (3) in situ bioremediation, and (4) subsurface manipulation/electrokinetics. Although set out as individual focus areas, these four are interrelated, and successful developments in one will often necessitate successful developments in another. In situ remediation technologies are increasingly being sought for environmental restoration due to the potential advantages that in situ technologies can offer as opposed to more traditional ex situ technologies. These advantages include limited site disruption, lower cost, reduced worker exposure, and treatment at depth under structures. While in situ remediation technologies can offer great advantages, many technology gaps exist in their application. This document presents an overview of ISPCT technologies and describes their applicability to DOE-complex needs, their development status, and relevant ongoing research. It also highlights research needs that the ISR IP should consider when making funding decisions.

5994 (DOE/EM–0223-Vol.1) **Report on DOE analytical laboratory capacity available to meet EM environmental sampling and analysis needs for FY 93-99.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). 30 Nov 1994. 50p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004505. Source: OSTI; NTIS; INIS; GPO Dep.

The DOE Analytical Laboratory Capacity Study was conducted to give EM-263 current information about existing and future analytical capacities and capabilities of site laboratories within the DOE Complex. Each DOE site may have one or more analytical laboratories in operation. These facilities were established to support site

missions such as production, research and development, and personnel and environmental monitoring. With changing site missions and the DOE directives for environmental monitoring and cleanup, these laboratories are either devoting or planning to devote resources to support EM activities. The DOE site laboratories represent a considerable amount of capital investment and analytical capability, capacity, and expertise that can be applied to support the EM mission. They not only provide cost-effective high-volume analytical laboratory services, but are also highly recognized analytical research and development centers. Several sites have already transferred their analytical capability from traditional production support to environmental monitoring and waste management support. A model was developed to determine the analytical capacity of all laboratories in the DOE Complex. The model was applied at nearly all the major laboratories and the results collected from these studies are summarized in this report.

5995 (DOE/EM–0223-Vol.2) **Appendices to report on DOE analytical laboratory capacity available to meet EM environmental sampling and analysis needs for FY 93-99.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). 30 Nov 1994. 383p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004506. Source: OSTI; NTIS; INIS; GPO Dep.

The DOE Analytical Laboratory Capacity Study was conducted to give EM-263 current information about existing and future analytical capacities and capabilities of site laboratories within the DOE Complex. Each DOE site may have one or more analytical laboratories in operation. These facilities were established to support site missions such as production, research and development, and personnel and environmental monitoring. With changing site missions and the DOE directives for environmental monitoring and cleanup, these laboratories are either devoting or planning to devote resources to support EM activities. The DOE site laboratories represent a considerable amount of capital investment and analytical capability, capacity, and expertise that can be applied to support the EM mission. They not only provide cost-effective high-volume analytical laboratory services, but are also highly recognized analytical research and development centers. Several sites have already transferred their analytical capability from traditional production support to environmental monitoring and waste management support. A model was developed to determine the analytical capacity of all laboratories in the DOE Complex. The model was applied at nearly all the major laboratories and the results collected from these studies are summarized in this report.

5996 (ETDE/DE-mf–95733420) **Optimal environmental policy despite incomplete information.** Humboldt-Universitaet zu Berlin, Fachbereich Wirtschaftswissenschaften. Discussion Paper, v. 1. Kritikos, A. Humboldt-Universitaet, Berlin (Germany). Fachbereich Wirtschaftswissenschaften. 1991. 24p. (In German). Order Number DE95733420. Source: OSTI; NTIS (US Sales Only).

When emissions by individual polluters can no longer be fully monitored additional sanctioning mechanisms are required to impose ecopolitical instruments. This study describes a sanctioning scheme consisting of a dual punitive system with an individual and a collective component which compels companies to effectively reduce emission while providing a workable stimulus to cooperate. The penalties are imposed whenever a randomly selected company is found to emit pollutants in excess of its limits permissible upon individual inspection, or if the aggregate emissions by all companies exceed a predefined immission value. It can be shown that the companies' collective emission reduction follows the course of a Nash Equilibrium. Moreover, unlike systems with exclusively individual or collective penalties, this system leads all the companies to the predominant strategy of reducing emissions to the expedient level and thus contributing to the equilibrium that optimally supports public welfare, subject to the condition that the penalties resulting from either type of offence are sufficiently severe. (orig.)

5997 (ETDE/JP-mf–95723030) **Current status and evaluation of response of enterprises to global environmental issues.** Science and Technology Agency, Tokyo (Japan). Mar 1994. 67p. (In Japanese). Order Number DE95723030. Source: OSTI; NTIS; Available from Science and Technology Agency, 2-1, Kasumigaseki 2-chome, Chiyoda-ku, Tokyo, Japan.

This report reveals the actual circumstances of countermeasures for global environmental issue in enterprises, and an evaluation table has been made for evaluating the status of their countermeasures. The enterprises take an great interest in the global environmental issue, and most of major enterprises are positive. Enterprises intend to form sound enterprise's image by the countermeasure for the global environmental issue. Countermeasures for the global environmental issue are mainly promoted in divisions of planning, research, development, and production. In order to promote countermeasures of global environmental issue, enterprises require the consolidation of conditions to the government, local self-government, nations, and industries. In order to evaluate the countermeasure of enterprise for the global environmental issue objectively, an all-round evaluation method is necessary. In this survey, a quantitative evaluation table has been made so that an enterprise can diagnose its own countermeasure for the global environmental issue. Using this evaluation table, a comparison with the other companies can be done. 21 refs., 23 figs., 30 tabs.

5998 (ETDE/JP-mf–95730143) **Preparatory research for global warming precaution spread promotion manual and early spread plan research work. Photovoltaic power generation spread plan research report.** Mitsubishi Research Inst., Inc., Tokyo (Japan). Mar 1994. 79p. (In Japanese). Order Number DE95730143. Source: OSTI; NTIS; Available from Mitsubishi Research Institute Inc., 3-6, Otemachi 2-chome, Chiyoda-ku, Tokyo, Japan.

This is the report on the planning research in spread and promotion of solar cell generation (SCG) prepared by Japan Environmental Agency. The main subject that is detailed in the report includes the necessity and evaluation of effects of the SCG as a potential effective means against global warming, and the scenario of policy for multiplex spread of the system over a wide area. For references, the effects of the SCG system on CO2 reduction and other description in 20 items with different data are annexed to the report. For necessity, the process of the SCG system up to date in Japan is described, but no policy is given on high costs that is adversely affecting the spread of the system. The secondary effect on cost reduction is expected to be enabled by increasing the ODA fund for developing countries. In other countries, such as the U.S.A., Germany, and Austria, the quick spread plan is being realized. For evaluation, three cases of demand forms are assumed to attempt to draw a future system and estimate the gradually increasing subsidy. The pattern of policy scenario was separately planned for up to 2000 and after 2000 and examination was conducted for each pattern. Both are based on the national consensus. 11 figs., 8 tabs.

5999 (IVL-B–1157) **Integrated environmental monitoring at the municipal level - a conceptual outline.** Frostell, B. (Royal Inst. of Technology, Stockholm (Sweden). Dept. of Environmental Technology and Work Science); Hallding, K.; Ekstrand, S.; Brandt, N. Swedish Environmental Research Inst., Stockholm (Sweden). 1994. 14p. (In Swedish). Order Number DE95723987. Source: OSTI; NTIS.

The purpose of this report is to show how an integrated environmental monitoring at the municipal level may make it possible to roughly quantify and analyze different mass- and energy flows. The present system for environmental monitoring is to some extent unsatisfactory. Integrated environmental monitoring is defined as 'a coordinated quantifying, analysis and presentation of all mass- and energy flows in air, water and soil within a geographically confined area'. Kommunlaadan is a conceptual model for this integrated environmental monitoring, where the municipality has been chosen as the basis for the collection and handling of environmental data. This approach may prove advantageous because the municipality is both a geographically confined area and a political/administrative decision-making body. Furthermore, the collection and analysis of data can take place in a decentralized way. The collection and storage of data together with knowledge about environmental effects may constitute a basis for decisions and priorities made in the municipality. Data to be coordinated in the model is of different types; mass flows crossing the municipal borders; production within the municipality; accumulation of material within the municipality

and the state of the environment. The basis for treatment and presentation of environmental data is an integrated analysis of map information, point data and model-results in a geographical information system. The conceptual model can only be realised if it is built up by a number of sub-models, which can be integrated into a larger system. The information may then ideally be integrated into balances for mass- and energy flows at the provincial and national levels. 5 refs, 2 figs

6000 (K/TCD–1118) **Vapor pressures of mixtures of CFC-114 with the potential replacement coolants C_4F_{10} and c-C_4F_8.** Trowbridge, L.D. (Oak Ridge K-25 Site, TN (United States)); Otey, M.G. Oak Ridge K-25 Site, TN (United States); Paducah Gaseous Diffusion Plant, KY (United States). Sep 1994. 34p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE95003444. Source: OSTI; NTIS; INIS; GPO Dep.

The U.S. Enrichment Corporation's production of isotopically enriched uranium depends solely on two plants which utilize the gaseous diffusion process. This process uses large quantities of CFC-114 as an evaporative coolant. CFC-114, however, will be phased out of production at the end of 1995 due to its potential to deplete stratospheric ozone. A search has been underway for substitutes for a number of years. The initial search (1988-89) for an ozone-friendly, commercially available, chemically compatible substitute yielded two candidates, FC-c318 (c-C_4F_8) and FC-3110 (C_4F_{10}). The intended mode of replacing coolant was to stage the new coolant into independent subsystems of the plants, so that some systems would continue to operate on CFC-114, and an increasing number would operate on the new coolant. During that changeover process, the possibility of coolant mixing arises in variety of scenarios. This work was intended to generate sufficient experimental information to be able to predict the vapor pressure of coolant mixtures over the range of operating conditions likely to be found in the diffusion plants. Specifically, vapor pressures were measured over the temperature range 322 to 355 K (120°F to 180°F) and over the full range of mole fractions for binary mixtures of CFC-114 with FC-3110, and of CFC-114 with FC-c318.

6001 (NEDO-GET–9203) **Investigation on the technical introduction scenario of CO2 fixation in the energy division. 3.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 163p. (In Japanese). Order Number DE95730265. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

Based on a future development scenario of CO2 fixation technology, the present study was made in order to develop models which can predict Japan's energy supply/demand structure as well as the effective decrease in CO2 emission. In fiscal 1992, the scenario was analyzed by case study through designing supply/demand structure from fiscal 1990 through 2030 and pigeonholing data on the premised conditions for those models. The comparison items were supply, system cost, CO2 emission, power required to be generated and energy demand. The scenarios on which the comparison was focused were supply/demand structure, CO2 levy, new energy introduction, CO2 emission control and CO2 fixation. Each of the above items was compared and analyzed from five viewpoints. Judging from the result of the present study, the mathematical model was developed which can analyze the influence of change in each of the different energy supply/demand-related conditions on the energy supply/demand and CO2 emission. 59 figs., 24 tabs.

6002 (NEDO-GET–9210-4) **Project to promote development of global environmental industry technology. Project for international research exchange.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1992. 377p. (In Japanese). Order Number DE95730261. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

The international research exchange project is to promote research exchange to solve the global environmental problem by NEDO with cooperation with RITE in inviting researchers from overseas to Japan and sending Japanese researchers overseas. As to global environmental related technology, to make broad research exchange between advanced overseas researchers and Japanese ones, eight researchers were invited and a joint research was made. Also, eleven researchers from Europe and the U.S. were invited to the West Pacific electrochemistry symposium, the international workshop on nitrous oxide emissions, and the international forum on environmental catalysis. To make effective promotion of researches of Japanese researchers and grasp the trend of research development overseas, five researchers were sent to universities and research institutes in Europe, and at the same time thirteen researchers were sent to international conferences and symposiums on global environmental industry technology. As a result, found is how fundamental studies on global environmental technology are progressing overseas. It is thought to be important to make further efforts for international exchanges. 107 refs., 105 figs., 24 tabs.

6003 (NEDO-GET–9212) **Technical trend investigation on the preservative measures by private firms for the global environment.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 109p. (In Japanese). Order Number DE95730264. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

Focused on the measures against CO2 for preventing the global warming which is one of the important environmental issues, the present survey was extensively made on the technical trend of R and D in progress by private firms, related organizations and universities for the environmental measures, together with their basic concept of future R and D. Through the present study, the necessary task was elucidated for effectively performing the global environment-related R and D. Based on the seeds and needs for the above R and D by private firms, the technical outlook was also elucidated for the future R and D to organize the preservative measures for the global environment. The present report more specifically exhibited the following matters: technical outlook for the future development of all environment-related technologies as well as their present status. Status and trend of grappling by private firms with the technical development and other environmental issues. Tasks necessary for the above grappling. Questionnaire survey result from private firms. Tasks and solving measures for promoting the technical development by private firms for the environmental issues of the globe. 6 figs., 4 tabs.

6004 (OCS/EIS/EA/MMS–94-0058-Vol.1) **Gulf of Mexico Sales 152 and 155: Central and Western Planning Areas. Final environmental impact statement, Volume 1: Sections I through IV.C.** Minerals Management Service, New Orleans, LA (United States). Gulf of Mexico OCS Region. Dec 1994. 331p. Sponsored by Department of the Interior, Washington, DC (United States). Source: OSTI; Minerals Management Service, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd., New Orleans, LA 70123-2394.

This environmental impact statement (EIS) addresses two proposed Federal actions that offer for lease areas in the Gulf of Mexico Outer Continental Shelf (OCS). These areas may contain economically recoverable oil and gas resources. Lease Sales 152 and 155 are proposed for 1995 and include lease blocks in the Central Gulf of Mexico Planning Area (CPA) and Western Gulf of Mexico Planning Area (WPA), respectively. Of the blocks that will be leased, only a portion will be drilled and result in subsequent production. The first step of the analysis is the identification of significant environmental and socioeconomic resources through the scoping process outlined in Section I.B.2.c.(1). A range of energy resource estimates is derived from geologic and economic assumptions, and alternatives to the proposed actions are established. Estimated levels of exploration and development activity are assumed for the purposes of the analysis. An analysis of the potential impacts expected from the interaction between the significant environmental resources and the OCS-related activities is then conducted. The scoping process (Section I.B.2.) was used to obtain information and comments on the proposed actions and the potential environmental effects from diverse interest, including the affected States, Federal agencies, the petroleum industry, environmental and public interest groups, and concerned individuals. The

input from these sources aided in the identification of significant issues, possible alternatives to the proposed actions, and potential mitigating measures. Volume 1 contains the proposed actions, the alternatives, and descriptions of the affected environment.

6005 (OCS/EIS/EA/MMS–94-0058-Vol.2) **Gulf of Mexico Sales 152 and 155: Central and Western Planning Areas. Final environmental impact statement, Volume 2: Sections IV.D through IX.** Minerals Management Service, New Orleans, LA (United States). Gulf of Mexico OCS Region. Dec 1994. 766p. Sponsored by Department of the Interior, Washington, DC (United States). Source: OSTI; Minerals Management Service, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd., New Orleans, LA 70123-2394.

This environmental impact statement (EIS) addresses two proposed Federal actions that offer for lease areas in the Gulf of Mexico Outer Continental Shelf (OCS). These areas may contain economically recoverable oil and gas resources. Lease Sales 152 and 155 are proposed for 1995 and include lease blocks in the Central Gulf of Mexico Planning Area (CPA) and Western Gulf of Mexico Planning Area (WPA), respectively. Of the blocks that will be leased, only a portion will be drilled and result in subsequent production. The first step of the analysis is the identification of significant environmental and socioeconomic resources through the scoping process outlined in Section I.B.2.c.(1). A range of energy resource estimates is derived from geologic and economic assumptions, and alternatives to the proposed actions are established. Estimated levels of exploration and development activity are assumed for the purposes of the analysis. An analysis of the potential impacts expected from the interaction between the significant environmental resources and the OCS-related activities is then conducted. The scoping process (Section I.B.2.) was used to obtain information and comments on the proposed actions and the potential environmental effects from diverse interest, including the affected States, Federal agencies, the petroleum industry, environmental and public interest groups, and concerned individuals. The input from these sources aided in the identification of significant issues, possible alternatives to the proposed actions, and potential mitigating measures. Volume 2 contains a description of the environmental consequences, consultation and coordination, a bibliography, glossary, and appendices.

6006 (ORNL/M–3271/R4) **Environmental regulatory update table: September/October 1994.** Houlberg, L.M.; Hawkins, G.T.; Bock, R.E.; Salk, M.S. Oak Ridge National Lab., TN (United States). Nov 1994. 104p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003898. Source: OSTI; NTIS; GPO Dep.

The Environmental Regulatory Update Table provides information on regulatory initiatives of interest to DOE operations and contractor staff with environmental management responsibilities. The table is updated bi-monthly with information from the Federal Register and other sources, including direct contact with regulatory agencies. Each table entry provides a chronological record of the rulemaking process for that initiative with an abstract and a projection of further action.

6007 (UCRL-JC–116777) **California's new environmental business development opportunities.** Rice, D.W. Jr. Lawrence Livermore National Lab., CA (United States). Mar 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9404125–2: Haz Mat West spring meeting, Long Beach, CA (United States), 26-28 Apr 1994). Order Number DE94018338. Source: OSTI; NTIS; GPO Dep.

California is facing economic challenges, but these challenges also create entrepreneurial opportunities. Today, a variety of partnerships among State, Federal, commercial, and private environmental restoration stakeholders is addressing these challenges. These partnerships include State and Federal regulatory agencies, such as the US and California Environmental Protection Agencies (EPA and Cal EPA); the US Department of Energy (DOE) and its National Laboratories; and private enterprises, particularly small environmental businesses. The mission of these partnerships includes the following: to provide strategic planning to streamline the regulatory processes; to find cost-effective technologies for environmental restoration and matches between problem holders and technology providers; to assist small businesses in securing funding; to provide information services; and to provide education and training, especially for environmental restoration managers.

6008 (UCRL-JC–118025) **Dealing with the Clean Water Act pending reauthorization.** Mathews, S. Lawrence Livermore National Lab., CA (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9408144–1: Conference on environmental regulations for federal facilities and government contractors, San Diego, CA (United States), 14 Aug 1994). Order Number DE94018069. Source: OSTI; NTIS; INIS; GPO Dep.

This report addresses probable changes in the Clean Water Act that may affect federal facilities such as those under the DOE. These changes will be included in a reauthorization of the act. The author draws upon the 1992 National Water Quality Inventory Report to Congress as a source to identify changes in the focus of the reauthorized act on non-point source issues, watershed management, new enforcement mechanisms and an assortment of smaller issues that will have indirect effects on federal facilities.

6009 (WSRC-IM–93-17-20) **Environmental implementation plan.** Peterson, G.L. Westinghouse Savannah River Co., Aiken, SC (United States). 4 Oct 1994. 162p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95004408. Source: OSTI; NTIS; INIS; GPO Dep.

In this document, the Savannah River site environmental programs and plans from DOE contractors and Westinghouse Savannah River Company divisions/departments are presented along with the environmental coordinator for each program. The objectives are to enhase communication of existing or planned programs to do the following: identify activities required for meeting environmental needs; identify needing resources and a schedule to accomplish those activities; promote share-savings and consistency in those activities.

6010 (WSRC-TR–93-347-Rev.2) **SRS ES&H Standards Compliance Program Implementation Plan. Revision 2.** Hearn, W.H. Westinghouse Savannah River Co., Aiken, SC (United States). 31 Aug 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95002180. Source: OSTI; NTIS; GPO Dep.

SRS initiated two parallel efforts to address aspects of Recommendation 90-2. An Order Compliance Program was established with initial focus on compliance with requirements contained in Environment, Safety, and Health (ES&H) related DOE Orders, both from a programmatic perspective as well as from a field adherence perspective; and a Standards/Requirements Identification Document (S/RID) development program was established to specify a "necessary and sufficient" set of ES&H requirements to protect the environment and public/worker safety and health. During the period while the S/RID methodology was being developed, many of the DOE ES&H Orders were revised and substantially improved. These improvements captured many of the insights gained in the developing S/RID program. As the SRS Order Compliance and S/RID programs matured and achieved major deliverables in 1993 and 1994, major overlaps between the two programs were identified. In early 1994, WSRC and DOE-SR determined that the two separate programs should be physically and organizationally integrated (and further merged with newly identified needs associated with Price-Anderson Amendments Act nuclear safety regulations) to become a single SRS Compliance Program. This document defines the program for integration of the WSRC Order Compliance, S/RID, and Price-Anderson Compliance activities. This plan supersedes the SRS ES&H Standards Compliance Program Management Plan and the SRS ES&H Standards Compliance Program Implementation Plan.

2904 Energy Resources

Refer also to citation(s) 6037

6011 (DOE/EIA–0249(94)) **Directory of energy data collection forms: Forms in use as of October 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Statistical Standards. 15 Dec 1994. 67p. Sponsored by USDOE,

Washington, DC (United States). Order Number DE95004329. Source: OSTI; NTIS; GPO Dep.

This 18th edition directory provides an overview of DOE's energy information collection programs for decisionmakers in Government and industry; selected public use forms currently used as basic energy information gathering tools by DOE are covered. For each form, an abstract is included that describes the form's uses, its respondents, and the data collected. Also shown are frequently requested items: energy sources and functions covered by the form, general categories of respondents, collection frequency, public laws and regulations, reporting requirement, name and phone number of the data collection manager, and the publications resulting from the data collection. Indexes, arranged according to energy source/function, publications, respondent categories, former EIA form number designations, and collection authorities, are provided.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 5182, 5991, 6052, 6053, 6081

6012 (ARO–95003980) **US Army Research Office research in progress, July 1, 1991–June 30, 1992.** Army Research Office, Research Triangle Park, NC (United States). 1992. 285p. Sponsored by Department of Defense, Washington, DC (United States). Source: OSTI; INIS; US Army Research Office, Attention AMXRO-RT-IP, P.O. Box 12211, Research Triangle Park, NC 27709-2211 (United States).

The US Army Research Office, under the US Army Materiel Command (AMC), is responsible for coordinating and supporting research in the physical and engineering sciences, in materials science, geosciences, biology, and mathematics. This report describes research directly supported by the Army Research Projects Agency, and several AMC and other Army commands. A separate section is devoted to the research program at the US Army Research, Development and Standardization Group - United Kingdom. The present volume includes the research program in physics, chemistry, biological sciences, mathematics, engineering sciences, metallurgy and materials science, geosciences, electronics, and the European Research Program. It covers the 12-month period from 1 July 1991 through 30 June 1992.

6013 (DOE/EA–0965) **Cancer Research Center Indiana University School of Medicine.** Department of Energy, Washington, DC (United States). Div. of Electric Energy Systems. Aug 1994. 40p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004416. Source: OSTI; NTIS; INIS; GPO Dep.

The Department of Energy (DOE) proposes to authorize the Indiana School of Medicine to proceed with the detailed design, construction and equipping of the proposed Cancer Research Center (CRC). A grant was executed with the University on April 21, 1992. A four-story building with basement would be constructed on the proposed site over a 24-month period. The proposed project would bring together, in one building, three existing hematology/oncology basic research programs, with improved cost-effectiveness through the sharing of common resources. The proposed site is currently covered with asphaltic pavement and is used as a campus parking lot. The surrounding area is developed campus, characterized by buildings, walkways, with minimal lawns and plantings. The proposed site has no history of prior structures and no evidence of potential sources of prior contamination of the soil. Environmental impacts of construction would be limited to minor increases in traffic, and the typical noises associated with standard building construction. The proposed CRC project operation would involve the use radionuclides and various hazardous materials in conducting clinical studies. Storage, removal and disposal of hazardous wastes would be managed under existing University programs that comply with federal and state requirements. Radiological safety programs would be governed by Nuclear Regulatory Commission (NRC) license and applicable Environmental Protection Agency (EPA) regulations. There are no other NEPA reviews currently active which are in relationship to this proposed site. The proposed project is part of a Medical Campus master plan and is consistent with applicable local zoning and land use requirements.

6014 (DOE/IG–0005) **Audit manual release 3.1.** Department of Energy, Washington, DC (United States). Office of Inspector General. Oct 1994. 665p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003983. Source: OSTI; NTIS; GPO Dep.

This document is release 3.1 of the Department of Energy Audit Manual. Release 3.1 incorporates policy changes suggested by the internal and external quality assurance reviews in areas such as the presentation of statistical sampling results and disclosure of scope impairments in reports. Additionally, Release 3.1 updates information on the Office of Audit Services and Team Leader name changes which occurred when this release was in printing; and expands guidance on (a) audit survey programs, (b) supervisory reviews of compliance with auditing standards, (c) Cost Accounting Standards Disclosure Statement Reviews, and (d) the Inspector Generals's Data Base Management System.

6015 (DOE/METC–94/1002, pp. 436-442) **Natural gas product and strategic analysis.** Layne, A.W.; Duda, J.R.; Zammerilli, A.M. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Product and strategic analysis at the DOE/Morgantown Energy Technology Center (METC) crosscuts all sectors of the natural gas industry. This includes the supply, transportation, and end-use sectors of the natural-gas market. Projects in the Natural Gas Resource and Extraction supply program have been integrated into a new product focus. Product development facilitates commercialization and technology transfer through DOE/industry cost-shared research, development, and demonstration (RD&D). Four products under the Resource and Extraction program include Resource and Reserves; Low Permeability Formations; Drilling, Completion, and Stimulation; and Natural Gas Upgrading.

6016 (DOE/METC–94/1002, pp. 521-529) **Natural gas recovery, storage, and utilization SBIR Program.** Shoemaker, H.D. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

The Small Business Innovation Research (SBIR) program was created in 1982 by Public Law 97-219 and reauthorized in 1992 until the year 2000 by Public Law 102-564. The purposes of the new law are to (1) expand and improve the SBIR program, (2) emphasize the program's goal of increasing private-sector commercialization of technology developed through Federal R&D, (3) increase small business participation in Federal R&D, and (4) improve the Federal Government's dissemination of information concerning the SBIR program.

6017 (NEDO-GET–9215) **Cooperation for the efficiency heightening of oil consumption in developing countries. Basic survey of oil consumption /invitation of engineers (from China).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 121p. (In Japanese). Order Number DE95730269. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

Chinese engineers were invited to pick out needs such as efficiency heightening of oil consumption, energy saving and other environmental technologies. Accounting for 20% of the world population, China continues increasing in population, and accordingly, energy demand from now on, so that the technical cooperation with foreign countries is an important matter of her policy. The business efficiency of public energy industry is low with much wasteful consumption, so that there is plenty of potential room for the energy saving. As a governmental strategy for developing the energy and decreasing the consumption, importance is attached to the adjustment of economic mechanism, administrative improvement and education. Information was exchanged about the technical training and teaching, and technological transfer and diffusion by inviting four Chinese engineers this time. From now on, it is indispensable to start with training engineers to be capable as a technical receiver

for the international cooperation project to be positively executed. It is therefore necessary to consecutively invite and train engineers.

6018 (NEDO-ITE–9110-3) **Development promotion of innovative technology for the earth. Feasibility study of research exchange.** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1993. 147p. (In Japanese). Order Number DE95730268. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

The feasibility of research exchange between Japan's Research Institute of Innovative Technology for the Earth (RITE) and different countries was studied in order to support the solving of global environment issues. In Germany's Environmental Technology Fair (ENVITEC), interest was great in environmental preservation machinery and equipment. In the UN Conference on Environment and Development (UNCED), listening was made to the process of agreeing to the Rio Declaration and Treaty on Framework Convention on Climate Change as well as their assertion, which was referred to by the planning of future environmental policy. In the US, the plant ultraviolet ray resistivity, genetic analysis, algae, photosynthesis, marine life and genetic operation were surveyed in three research institutes with their interests felt in common with RITE's research. In Australia, interest was felt in anti-warming measures, solar energy development (particularly, hydrogen production in the desert) and CO2 global recycling, together with the wind energy and tidal energy which might be both promising. The research exchange with the RITE was judged feasible. The UAE, Kuwait and Saudi Arabia where the trend of research on the tree-planting in the desert was surveyed look forward to Japanese technical assistance for the biotechnological improvement of plants. 19 figs., 5 tabs.

6019 (NEI-DK–1744) **EU databases, with special emphasis on THERMIE and JOULE.** Energy Centre Denmark, Copenhagen (Denmark). Oct 1994. 32p. (In Danish). Contract ENS-151/94-0016. Order Number DE95723844. Source: OSTI; NTIS.

The aim of the investigation of the European Union's (EU) databases was to evaluate the usefulness, the limits, the relevance and the reliability of the descriptions of research projects related to energy which are carried out under the THERMIE and JOULE programmes. The method was to identify the relevant databases and describe the process of access to data on research projects under the THERMIE and JOULE programmes, to describe which types of information are found in the relevant databases and to evaluate the quality of this information and of the databases in relation to the needs of the Danish Energy Agency (which functions under the auspices of the Danish Ministry of Energy). Other aims were to produce a survey of projects in which Danish researchers have participated, to offer suggestions as to how such surveys should be conducted in the future, to identify any weaknesses in the databases and to give recommendations for their improvement. The THERMIE programme (projects related to energy technology) is administrated by the European Commission's Directorate-General for Energy (XVII) and the JOULE programme (non-nuclear-energy research projects) is administrated by the (Commission's Directorate General for Science, Research and Development). It is concluded that THERMIE projects are best described in the SESAME database (EUROBASES) but are also found in the CORDIS database (ECHO). JOULE projects are described in CORDIS but not in SESAME. The SESAME and CORIS databases are described in detail. (AB)

6020 (SAND–94-2699C) **Research management at the interfaces.** Westwood, A.R.C. Sandia National Labs., Albuquerque, NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941240–1: International conference on professionalism and excellence in R&D, London (United Kingdom), 3-6 Dec 1994). Order Number DE95003356. Source: OSTI; NTIS; GPO Dep.

This contribution presents some lessons learned in the development of cooperation and knowledge transfer across the numerous interfaces involved in managing a corporate research laboratory.

6021 (VTT-TIED–1507) **Technology transfer between research laboratories and industry. Measurement and evaluation.** Laamanen, T. (VTT, Espoo (Finland). Group of Technology Studies); Autio, E. Technical Research Centre of Finland, Espoo (Finland). 1993. 89p. Order Number DE95723872. Source: OSTI; NTIS.

The purpose of this study is to survey the existing literature on technology transfer, to present categorizations of the various technology transfer mechanisms, and to present criteria, indicators, and measures for the measurement of the effectiveness of technology transfer. The study focuses mainly on contract research and development projects, research and development consortia, and new technology-based companies. In technology transfer research, two main categories can be identified. The traditional approach has focused on technology transfer between industrialized and developing countries. This approach can be labelled as: 'developing country oriented technology transfer research'. The modern approach to technology transfer research focuses on technology interchanges between various actors in the economy. This approach can be labelled as: 'innovation oriented technology transfer research'. This present study belongs to the latter category. In measuring technology transfer, several factors affecting the transfer should be taken into account. These are, for example, research institute-oriented factors, industry-oriented factors, national technological infrastructure, and the nature and the maturity of the technology transferred. In addition, the dimensions of the ways to transfer technology should be taken into account. An important distinction in the context of technology transfer indicators is the distinction between input-output indicators and process indicators. It is argued that the traditional approach has tended to focus largely on input-output indicators. It is suggested that process indicators should be given increased attention. It is proposed that in the evaluation of research, the recent developments in innovation research should be taken into account.

2906 Nuclear Energy

Refer also to citation(s) 5131, 5144, 5145, 5146, 5147, 5148, 5149, 5312, 5467, 5740, 5741, 5744, 6037, 6038, 6057, 6066

6022 (DOE/AN/ACNT–94C, pp. 5-7) **Overview: Reciprocal inspections of fissile material removed from nuclear weapons.** Percival, C.M.; Ingle, T.H. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

Transparency in nuclear disarmament and the continuing control of fissile material from nuclear weapons have been goals since the end of the cold war and the beginning of reductions in nuclear stockpiles. The United States and Russia have taken a bold step in nuclear disarmament by announcing their intention to host reciprocal inspections of fissile materials removed from nuclear weapons. While important questions still have to be answered, the sides are taking a step-by-step approach toward confirming fissile material inventories from nuclear disarmament. Here we review the events leading to this announcement and discuss U.S. views on how the inspections should be implemented.

6023 (DOE/AN/ACNT–94C, pp. 24-26) **Nuclear Weapons Identification System.** Mihalczo, J.T. (Oak Ridge National Lab., TN (United States)); Pare, V.K. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

The Nuclear Weapons Identification System (NWIS) can be used to identify nuclear weapons or components and fissile materials retrieved from dismantled weapons. Because it detects and analyzes a large number of various kinds of signals, the system is very difficult to deceive. The NWIS is already in use in the Weapons Returns Program at the DOE Y-12 Plant, a portable version is under development.

6024 (DOE/AN/ACNT–94C, pp. 27-28) **Wide-area nuclear detection for monitoring and tracking nuclear-weapon material.** Koenig, Z.M. (Lawrence Livermore National Lab., CA (United States)); Gosnell, T.B.; Rowland, M.S.; Imbro, D.R. USDOE Office

of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

The wide-area nuclear detector (WAND) concept, which incorporates multiple detectors in a sensor network, can provide detection, characterization, and monitoring/tracking of nuclear-weapon material for treaty verification, environmental monitoring, and other U.S. government operational requirements. It can be scaled as needed from small areas such as seaports to large areas, taking advantage of the topology of a large region to deploy a cost-effective network. WAND, therefore, has many of the features of a remote sensor.

6025 (DOE/AN/ACNT–94C, pp. 29-32) **Methods for identifying and confirming nuicear warheads without using nuclear radiation.** Schwegler, E.C. Jr. (Los Alamos National Lab., NM (United States)); Apt, K.E. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

An important question in the build-down of nuclear arsenals is how to ensure that decommissioned items are actually retired or dismantled. Although the United States and Russia can assert that certain weapons systems are being removed from their stockpiles and placed under nonmilitary control, cooperative transparency measures may be needed to provide good-faith demonstrations that such has occurred. Moreover, future nuclear dismantlement agreements might require capabilities that distinguish nuclear weapons or their components from surrogates. Methods that use radiation measurements to do this can be too intrusive because they may compromise sensitive design information; we are evaluating techniques that can identify nuclear warheads without using radiation.

6026 (DOE/AN/ACNT–94C, pp. 33-35) **Acoustic resonance spectroscopy in support of arms control and nonproliferation transparency.** Olinger, C.T. (Los Alamos National Lab., NM (United States)). USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

Acoustic resonance spectroscopy (ARS) provides a nonintrusive means of detecting changes in a sealed item, such as a container of weapons components. The acoustic spectrum of a container is a function of its geometry, material of construction, and parameters of the contents such as the speed of sound within the material, its viscosity, and compositions as well as the occupied volume of the container. Measuring the spectrum establishes a "fingerprint" for that item. Monitoring for changes in the fingerprint can be used to detect significant changes of the contents or container. Such information can be used in transparency regimes in which it is desirable to demonstrate that material declared has not been removed without revealing much information about the material itself.

6027 (DOE/AN/ACNT–94C, pp. 38-40) **Stockpile dismantlement database: A tool for weapon parts disposition planning.** Eaton, D.S. (Sandia National Labs., Albuquerque, NM (United States)); Burger, R.J. USDOE Office of Nonproliferation and National Security, Washington, DC (United States). 1994. In *Arms control and nonproliferation technologies, third quarter 1994. Dismantlement transparency.* 46p. Order Number DE95001068. Source: OSTI; NTIS; GPO Dep.

Driven by treaty agreements and reconfiguration of both the Department of Defense and the DOE complexes, DOE is faced with disassembling and dispositioning huge inventories of retired weapons, training equipment, spare parts, and weapon-maintenance equipment. In addition, new regulations have caused a dramatic increase in the amount of information needed for supporting the environmentally conscious handling of those parts and materials. The Stockpile Dismantlement Database (SDDB) was developed by Sandia National Laboratories to be the central repository for information supporting weapon disassembly and disposition (recycle/disposal). It allows DOE and the nuclear weapon complex agencies to easily access and share large volumes of dismantlement information.

6028 (NUREG–0750-Vol.40-No.4) **Nuclear Regulatory Commission issuances.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Freedom of Information and Publications Services. Oct 1994. 27p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; INIS; GPO.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judges (ALJ), the Directors Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM). The summaries and headnotes preceding the opinions reported herein are not to be deemed a part of those opinions or have any independent legal significance.

6029 (NUREG–1145-Vol.9) **1992 Nuclear Regulatory Commission Annual Report.** Nuclear Regulatory Commission, Washington, DC (United States). 31 Jul 1993. 285p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This is the 18th annual report of the US Nuclear Regulatory Commission (NRC), covering events and activities occurring in fiscal year 1992 (the year ending September 30, 1992), with some treatment of events from the last quarter of calendar year 1992. The NRC was created by enactment in the Congress of the Energy Reorganization Act of 1974. It is an independent agency of the Federal Government. The five NRC Commissioners are nominated by the President and confirmed by the United States Senate. The Chairman of the Commission is appointed by the President from among the Commissioners confirmed.

6030 (NUREG–1350-Vol.5) **Nuclear Regulatory Commission information Digest: 1993 edition.** Nuclear Regulatory Commission, Washington, DC (United States). Div. of Budget and Analysis. Mar 1993. 115p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

The Nuclear Regulatory Commission Information Digest (digest) provides a summary of information about the U.S. Nuclear Regulatory Commission (NRC), NRC's regulatory responsibilities, the activities NRC licenses, and general information on domestic and worldwide nuclear energy. The digest, published annually, is a compilation of nuclear- and NRC-related data and is designed to provide a quick reference to major facts about the agency and the industry it regulates. In general, the data cover 1975 through 1992, with exceptions noted. Information on generating capacity and average capacity factor for operating U.S. commercial nuclear power reactors is obtained from monthly operating reports that are submitted directly to the NRC by the licensee. This information is reviewed by the NRC for consistency only and no independent validation and/or verification is performed. Comments and/or suggestions on the data presented are welcomed and should be directed to Karen Olive, United States Nuclear Regulatory Commission, Office of the Controller, Division of Budget and Analysis, Washington, D.C. 20555. For detailed and complete information about tables and figures, refer to the source publications.

6031 (VKTA–94-16) **Annual report 1993 by the Rossendorf Society of Nuclear Engineering and Analysis.** Haefele, W. (ed.). Verein fuer Kernverfahrenstechnik und Analytik Rossendorf e.V. (VKTA), Dresden (Germany). Mar 1994. 75p. (In German). Order Number DE95726787. Source: OSTI; NTIS (US Sales Only); INIS.

The second annual report contains, apart from the business report and the organigram, priorities and results achieved in the special fields of nuclear installations (decommissioning and disposal), nuclear waste management (radioactive wastes), nuclear analyses and rehabilitation, radiopharmaceuticals, and safety and radiation protection. (HP)

2908 Heat Utilization

Refer also to citation(s) 6063, 6090, 6091

2910 Conservation

Refer also to citation(s) 5979, 6017, 6052, 6053, 6066

6032 (CONF-9403188–, pp. 113-115) **Presentation on the World Energy Efficiency Association.** Guertin, D. Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At the Maui meeting of U.S.-Japan Energy Consultations, Mr. Gardin of the Atlantic Council outlined the WEEA (World Energy Efficiency Association). According to this explanation, the WEEA should lead the world's energy economization, building the network throughout the world through which governments and private companies of different countries should support enhancement of energy efficiency. The WEEA locates its head office in Washington D.C. and serves as a clearing house of information on energy efficiency. The EU has been strongly supporting this attempt, even in the financial aspect at a higher level than expected. The WEEA is also obtaining the financial support from the U.S.'s Agency for International Development (USAID). In Japan, the General Energy Promotion Committee is in cooperation with the WEEA. The WEEA's charter provides that 50% of the board of directors and 50% of the committee of the board of directors shall consist of the representatives from non-OECD countries. The current chairman of the WEEA, Mr. Ragraman, is an Indian. India is a non-OECD country.

6033 (ETDE/DE-mf–95733457, pp. 53-58) **Rational use of energy in the area of electricity.** Wilkens, B. Gesellschaft fuer Organisation, Planung und Ausbildung mbH (GOPA), Bad Homburg (Germany). 1990. 177p. (In German). In *Prospects: 25 years GOPA 1990.* Order Number DE95733457. Source: OSTI; NTIS (US Sales Only).

Due to high conversion losses in electricity generation and the resulting pollutant emissions rational use of electricity is of great importance. Sulphur dioxide and nitrogen oxide emissions in conventional thermal power plants have a decisive influence on the quality of air. Due to carbon dioxide which develops in combustion processes negative impacts on the global climate are feared. Measures for rational use of electricity are important for the solution of these problems. In this article the demand for and energy intensity of electricity in important industrialized countries is gone into and individual measures and technologies for a further increase in the efficiency of electricity use are discussed. (orig./UA)

6034 (NREL/TP–472-7293) **Federal Renewable Energy Screening Assistant.** Shelpuk, B. (Natural Energy Resources Unlimited, Evergreen, CO (United States)); Walker, A. National Renewable Energy Lab., Golden, CO (United States). Oct 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-950336–8: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95000220. Source: OSTI; NTIS; GPO Dep.

The Federal Renewable Energy Screening Assistant is a software tool to be used by energy auditors to prioritize future studies of potentially cost-effective renewable energy applications at federal facilities. This paper describes the structure and function of the tool, gives an inventory of renewable energy technologies represented in the tool, and briefly describes the algorithms used to rank opportunities by the savings-to-investment ratio.

2920 Supply, Demand, and Forecasting

Refer also to citation(s) 6001, 6011, 6044, 6045, 6046, 6047, 6048, 6049, 6050, 6066

6035 (CONF-9403188–, pp. 50-98) **Changes of and prospects for energy supply and demand in the Asia-Pacific region.** Fujime, K. (The Institute of Energy Economics, Tokyo (Japan)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

A report on energy supply and demand in the Asia-Pacific Region at the Maui meeting of U.S.-Japan Energy Policy Consultations was presented by Mr. Fujime, the Institute of Energy Economics. Demand for primary energy in the Asia-Pacific Region showed a share of 15.1% in the world's total in 1971, but in 1990 it increased to 21.9%. According to IEA's outlook, it will reach 30% of the world's total by 2010. Especially for China, demand for primary energy is expected to reach 10.3%. In the composition of primary energy supply, the use of coal has increased, registering about 47% in this region, against the world's coal ratio of about 30%. The rate in the Asia-Pacific Region is expected to remain unchanged. Power plant fuel shifted from oil to gas and hydroelectric power, etc. Oil supply is expected to decrease from 48.5% in 1971 to about 34.3% in 2010. Atomic power is expected to increase at an annual rate of about 4.1% on the average in 2010. 16 figs., 26 tabs.

6036 (CRIE-T–91045) **Generation planning and global environmental problems in the Asian and Pacific.** Nanahara, T.; Nagao, T. Central Research Inst. of Electric Power Industry, Komae, Tokyo (Japan). Energy and Environment Lab. May 1992. 66p. (In Japanese). Order Number DE95730177. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

Mainly from the viewpoint of power generation planning, measures for the wide-region environmental preservation were studied through surveying and analyzing the supply and demand trend of energy and power in the Asia-Pacific region. In that region, the demand is quantitatively large in China, India and Japan, while its growth rate is very high in the developing countries and new industrial countries. Particularly, the power demand surpasses the energy demand in growth rate with progress remarkably made in electrification. As for the composition of generated power, the oil burning power generation is being prevailingly developed in most of the countries. Taking the situation of each country into consideration, the feasibility was studied, from the viewpoint of power generation planning, of taking the anti-CO2 and other measures for the wide-region environmental preservation. As a result, what is promising is the rise in energy efficiency for the short term, and development of gas energy, recyclable energy and nuclear energy for the long term. However because of complicated diversity in energy situation of each country, the international consensus is difficult to reach for the wide-region environmental issue. 22 refs., 14 figs., 14 tabs.

6037 (DOE/EIA–0035(94/11)) **Monthly energy review, November 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Nov 1994. 176p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003486. Source: OSTI; NTIS; INIS; GPO Dep.

This monthly publication contains statistical data on energy resources in the United States. Petroleum, natural gas, coal, electricity, and nuclear energy are covered. Additional sections include an energy overview, energy consumption, oil and gas resource development and energy prices. This issue includes features on energy-related housing characteristics and the propane-provider fleet.

6038 (DOE/EIA–0035(94/12)) **Monthly energy review, December 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1994. 177p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004483. Source: OSTI; NTIS; INIS; GPO Dep.

This monthly publication contains statistical data on energy resources in the United States. Petroleum, natural gas, coal, electricity, and nuclear energy are covered. Additional sections include an energy overview, energy consumption, oil and gas resource development and energy prices. This issue includes a market assessment of alternative-fuel vehicles in the Atlanta private fleet for 1994.

6039 (DOE/EIA–0226(94/11)) **Electric power monthly, November 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. Nov 1994. 218p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003494. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

The Electric Power Monthly (EPM) presents monthly electricity statistics. The purpose of this publication is to provide energy decisionmakers with accurate and timely information that may be used in forming various perspectives on electric issues that lie ahead. Data in this report are presented for a wide audience including Congress, Federal and State agencies, the electric utility industry, and the general public. The EIA collected the information in this report to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93-275) as amended.

6040 (DOE/EIA–0538(94/95-13)) **Winter fuels report. Week ending: January 6, 1995.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 12 Jan 1995. 77p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95005090. Source: OSTI; NTIS; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policymakers, consumers, analysts, and State and local governments on the followings topics: distillate fuel oil net production, imports and stocks on a US level and for all Petroleum Administration for Defense Districts (PASS) and product supplied on a US level; propane net production, imports and stocks on a US level and for PADD's I, II, and III; natural gas supply and disposition and underground storage for the US and consumption for all PADD's; as well as selected National average prices; residential and wholesale pricing data for heating oil and propane for those States participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane Program; crude oil and petroleum price comparisons for the US and selected cities; and a 6–10 Day, 30-Day, and 90-Day outlook for temperature and precipitation and US total heating degree-days by city.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 5757, 6008, 6056, 6125, 6131, 6167

6041 (ETDE/DE-mf–95726784) **Energy policy and climate protection in Hessen. An expertise for the Ministry of Hessen for the Environment, Energy and Federal Affairs.** Gruber, E. (Fraunhofer-Institut fuer Systemtechnik und Innovationsforschung (ISI), Karlsruhe (Germany)); Jochem, E.; Mannsbart, W.; Schlomann, B. Ministerium fuer Umwelt, Energie und Bundesangelegenheiten des Landes Hessen, Wiesbaden (Germany). Apr 1994. 166p. (In German). Order Number DE95726784. Source: OSTI; NTIS (US Sales Only).

The publication first of all describes the energy political situation of the Land Hessen and its energy policy in recent years. The following fields of action are mentioned with a view to attaining the climate protection goal: harnessing of energy conservation potentials in the sector of space heat in residential buildings as well as industry, trade and administration; process heat energy conservation; harnessing of electric power conservation potentials; heat-and-power cogeneration and the supervision of public utilities. (KW)

6042 (ETDE/DE-mf–95733236) **New structure of the boundary conditions of energy law and communalisation of electricity supply.** Volkswirtschaftliche Diskussionsreihe, v. 93. Lang, G. Augsburg Univ. (Germany). Inst. fuer Volkswirtschaftslehre. Jun 1993. 28p. (In German). Order Number DE95733236. Source: OSTI; NTIS (US Sales Only).

Points relating to economic policy in the German energy policy are shaped not only by national and supranational legislative powers, but also to a large extent by the local authorities. The areas under local authority are set out at a country level, illustrating a further development of the "Germany law governing local authorities" in 1935. Many areas have not hesitated to use their powers in establishing their own supply utilities. The communalisation of the energy supply brings it once again to the forefront of discussions; it represents strengthened founding opportunities as well as the decentralisation of the power plant structure. This study aims to illustrate and provide an economic interpretation of the fourth and fifth regulations on hindrances to competition against the background of the present intervention system and current market structure of the energy sector (chapter 2 and 3). Further to that, the improvements of local authority's opportunities to construct their own electricity production capacity in the new framework are explored, and the likely economic consequences (chapter 4). A summary and evaluation of the results is given in chapter 5. (UA)

6043 (NEI-SE–182) **Environmental impact assessment in Estonia.** Peterson, K. (comp.). Stockholm Environment Inst., Tallin (Estonia). 1994. 78p. (In , English). Order Number DE95723964. Source: OSTI; NTIS.

Full text in both the Estonian and English language.

Environment impact assessment (EIA) is an important procedure for ensuring that the likely effects of a development on the environment are fully understood and taken into account before the development is allowed to go ahead. This publication provides people involved in EIA, like developers and their advisers, experts and consultants, first-hand information on the process of EIA in Estonia. Chapter 1 gives the full text of the Estonian Government Order No314 from 13.11.1992 on the Environmental Impact Assessment in Estonia. This is the first legal document on EIA in Estonia and is regarded as a framework document setting general principles of EIA. Chapter 2 gives the full text of the Order of the Estonian Minister of Environment No8 from 14.03.1994 on the Methodological Guidelines for Implementing Environmental Impact Assessment in Estonia. The Order elaborates further on the procedures of EIA and gives a developer practical approach, what data is needed to be submitted to competent authority, and also provides experts with practical assignments that should be undertaken while compiling an environmental impact statement (EIS). The Order should be regarded as an attachment to the earlier framework document. Both documents express the important role of the public in the EIA process for the first time in environmental legal acts of Estonia. Estonian administrative system is going through a reform. By date, there are fifteen counties and 193 districts. In the following text county governments and corresponding environmental departments are regarded as 'regional level' authorities, whereas the Ministry of Environment - as the 'state level' authority. The 'regional level' also concerns two cities - Tallinn and Narva, which have city environmental departments.

2940 Fossil Fuels

Refer also to citation(s) 4993, 5016, 5017, 5020, 5021, 5022, 5072, 5073, 6015, 6017, 6037, 6038, 6040, 6062, 6063, 6069, 6131

6044 (ANL/DIS/TM–20) **Natural gas contracts in efficient portfolios.** Sutherland, R.J. Argonne National Lab., IL (United States). Dec 1994. 65p. Sponsored by USDOE, Washington, DC (United States);Maryland State Government, Annapolis, MD (United States). DOE Contract W-31109-ENG-38. Order Number DE95004274. Source: OSTI; NTIS; GPO Dep.

This report addresses the "contracts portfolio" issue of natural gas contracts in support of the Domestic Natural Gas and Oil Initiative (DGOI) published by the U.S. Department of Energy in 1994. The analysis is a result of a collaborative effort with the Public Service Commission of the State of Maryland to consider "reforms that enhance the industry's competitiveness". The initial focus of our collaborative effort was on gas purchasing and contract portfolios; however, it became apparent that efficient contracting to purchase and use gas requires a broader consideration of regulatory reform. Efficient portfolios are obtained when the holder of the portfolio is affected by and is responsible for the performance of the portfolio. Natural gas distribution companies may prefer a diversity of contracts, but the efficient use of gas requires that the local distribution company be held accountable for its own purchases. Ultimate customers are affected by their own portfolios, which they manage efficiently by making their own choices. The objectives of the DGOI, particularly the efficient use of gas, can be achieved when customers have access to suppliers of gas and energy services

under an improved regulatory framework. The evolution of the natural gas market during the last 15 years is described to account for the changing preferences toward gas contracts. Long-term contracts for natural gas were prevalent before the early 1980s, primarily because gas producers had few options other than to sell to a single pipeline company, and this pipeline company, in turn, was the only seller to a gas distribution company.

6045 (CONF-9403188–, pp. 123-125) **Outlook for U.S. coal and related issues.** Lawson, R. (National Coal Association, (United States)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy Consultation, Mr.Lawson from the National Coal Association lectured on a perspective of supply and demand for coal in the U.S., demand for export, environmental issues, and others. The total estimated demand for coal in the U.S. for 1994 will be as large as 1.033 billion tons, the highest record in the history of coal in the U.S. More coal will be required in future, because thermal power generation using coal will increase from the current level of 56% to about 60%. In 2005 - 2010, the so-called clean coal technology will commercially be utilized, further increasing the demand for coal. The export of coal from the U.S.A. has been decreased for the past 3 years. European countries are hesitating to start new coal programs because of voluntary exploitation and environmental issues. These countries will probably support U.S. coal. The U.S. Congress vetoed the motions about carbon dioxide and the carbon tax. This is to put importance on the scientific grounds, without giving priority to politics.

6046 (CONF-9403188–, pp. 126-128) **Coal and related issues.** Shirakawa, T. (Electric Power Development Co. Ltd., Tokyo (Japan)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S-Japan Energy Consultation, Mr. Shirakawa from Electric Power Development, Co., Ltd. lectured on supply and demand for coal and the issues of securing the stable supply of coal in the Asia-Pacific Zone. The continued dull business in the world economy has decreased the demand in the international coal market, keeping the price at a lower level. However, the demand for general coal will greatly increase in the Asia-Pacific Zone as an energy to support the high economic growth in this area, until the demand reaches about 180 million tons by 2000, almost two times as much as in 1992. Similarly in Japan, the import of coal will be doubled by 2000. As a petroleum substitution energy, the demand for mainly general coal for electric power will increase. The trend of supply and demand for coal will depend on the demand in non-OPEC countries because consumption in these countries will account for 60% or more of the world's consumption. It is important, therefore, that coal consumption in these developing countries should be reduced by supporting improvement of energy efficiency of these countries and helping to solve the environmental problems related to harmful exhaust gases such as SOx.

6047 (CONF-9403188–, pp. 135-146) **U.S.-Japan Energy Consultation, Maui Meeting. Petroleum and related issues.** Ito, M. (Nippon Oil Co. Ltd., Tokyo (Japan)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy consultation, Mr.Ito from Nippon Oil Co., Ltd. lectured on the trend of supply and demand for petroleum, the trend after Japan's deregulation, and the future role of Japan. In 1993, the world's petroleum market had a negative growth after an interval of 10 years since 1983, reflecting the delayed economic recovery. Since the North Sea Petroleum and other non-OPEC countries have continued to increase production inspite of the decreasing demand, the excessive supply has maintained the petroleum price at a very low level. The regulation to Japanese oil industry started in 1987 and has completed its program in five years. However, the initial target of 'acquiring the constitution competitive in the international market' has not been achieved. Further deregulation will be examined. The company gives the highest priority to securing the stable supply of petroleum. It is believed that Japan's role as continuing efforts to secure crude oil that should be developed by Japan in order to establish a worldwide stable supply system. And it is also said that technologies for saving energy and preserving environments must be transferred and financial support for that must be offered to developing countries. 1 fig., 9 tabs.

6048 (DOE/EIA–0130(94/12)) **Natural gas monthly, December 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. Dec 1994. 109p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003872. Source: OSTI; NTIS; GPO; GPO Dep.

The Natural Gas Monthly (NGM) is prepared in the Data Operations Branch of the Reserves and Natural Gas Division, Office of Oil and Gas, Energy Information Administration (EIA), US Department of Energy (DOE). The NGM highlights activities, events, and analyses of interest to public and private sector organizations associated with the natural gas industry. Volume and price data are presented each month for natural gas production, distribution, consumption, and interstate pipeline activities. Producer-related activities and underground storage data are also reported. The data in this publication are collected on surveys conducted by the EIA to fulfill its responsibilities for gathering and reporting energy data. Some of the data are collected under the authority of the Federal Energy Regulatory Commission (FERC), an independent commission with in the DOE, which has jurisdiction primarily in the regulation of electric utilities and the interstate natural gas industry. Geographic coverage is the 50 States and the District of Columbia.

6049 (DOE/EIA–0538(94/95-9)) **Winter fuels report, Week ending December 2, 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 8 Dec 1994. 77p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003984. Source: OSTI; NTIS; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policy makers, consumers, analysts, and State and local governments on the following topics: distillate fuel oil net production, imports and stocks on a US level and for all Petroleum Administration for Defense Districts (PADD) and product supplied on a US level; propane net production, imports and stocks on a US level and for PADD's 1, 2, and 3; natural gas supply and disposition and underground storage for the US and consumption for all PADD's; as well as selected National average prices. Residential and wholesale pricing data for heating oil and propane for those States participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane Program; crude oil and petroleum price comparisons for the US and selected cities; and a 6–10 Day, 30-day, and 90-Day outlook for temperature and precipitation and US total heating degree-days by city.

6050 (DOE/EIA–0538(94/95-12)) **Winter fuels report, Week ending December 30, 1994.** USDOE Energy Information Administration, Washington, DC (United States). Office of Oil and Gas. 6 Jan 1995. 78p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004746. Source: OSTI; NTIS; GPO Dep.

The Winter Fuels Report is intended to provide concise, timely information to the industry, the press, policy makers, consumers, analysts, and State and local governments on the following topics: distillate fuel oil net production, imports and stocks on a US level and for all Petroleum Administration for Defense Districts (PADD) and product supplied on a US level; propane net production, imports and stocks on a U.S. level and for PADD's 1, 2, and 3; natural gas supply and disposition and underground storage for the US and consumptive for all PADD's; as well as selected National average prices. Residential and wholesale pricing data for heating

oil and propane for those States participating in the joint Energy Information Administration (EIA)/State Heating Oil and Propane Program; crude oil and petroleum price comparisons for the US and selected cities; and a 6–10 Day, 30-Day, and 90-Day outlook for temperature and precipitation and US total heating degree-days by city.

6051 (ETDE/DE-mf–95733346) **Rheinbraun AG. Annual report 1992/93. From July 1, 1992 to June 30, 1993.** Rheinbraun AG, Koeln (Germany). 1993. 41p. (In German). Order Number DE95733346. Source: OSTI; NTIS (US Sales Only).

A description of the tasks and activities of this major brown coal (lignite) mining company is given, providing financial data from the year end 1992/93 (balance sheet, profit and loss account etc.). (UA)

6052 (NEDO-GET–9216-1) **Cooperation project for making petroleum consumption in developing countries efficient/ fundamental survey on petroleum consumption in developing countries. Part 1. Cooperation survey on making petroleum consumption efficient (Malaysia).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1992. 301p. (In Japanese). Order Number DE95730267. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

To make petroleum consumption efficient in Malaysia, cooperation survey was conducted for the purpose of finding out needs for energy conservation and environmental technology and giving technical cooperation. Malaysia reserves oil and natural gas, and exports a part of them. To get rid of petroleum dependence, Malaysia started to give priority to natural gas, coal and palm oil as energy, and the rate of petroleum in the domestic energy demand reduced from 71% in 1985 to 60% in 1990. However, utilization by energy source is unbalanced, and promotion of efficient petroleum consumption and energy conservation/environmental technology is not sufficient. Policies for energy conservation and environment have just started on a national level, and it takes a little time to make them diffuse to individual enterprises. For this, required are promotion systems, training of engineers, PR campaign, recognition and establishment of the system of energy saving equipment. Facilities and equipment in energy multi-consumed sections are old-fashioned, and subjects in question are promotion of efficiency and measures taken for environmental protection. It is necessary to make a continued concentrating survey in these sections. 5 refs., 3 figs., 5 tabs.

6053 (NEDO-GET–9217) **Cooperation project for making petroleum consumption in developing countries efficient/ fundamental survey on petroleum consumption in developing countries. Exchange of engineers (Malaysia).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Dec 1992. 223p. (In Japanese). Order Number DE95730266. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan.

To make petroleum consumption in Malaysia efficient, exchanges of local engineers were made for the purpose of cooperating with an effective spread of energy conservation and environmental technologies in Japan. The conference was held with the presence of members of the Japanese engineers exchange group and representatives of energy related sections of the Malaysian government and major enterprises. Malaysia is high in annual economic growth rate, 7-8 %, and has an interest in energy conservation and environment. The problem of electric power shortage becomes conspicuous, and attainment of energy conservation of 20% for 2020 is targeted as a national plan. However, the industrial circle is not so much conscious of energy conservation, and therefore, improvement of equipment and energy conservation which cost much are not expected. The government aims at a high-level economy growth for national prospect, and puts off their tackling with the energy conservation and environmental problems pertaining to the economical development. Leaving introduction of energy saving type high efficiency equipment in the hands of users, the government considers no special financial assistance or interest supply. It takes time to really spread energy conservation and environmental technologies, and training of engineers and establishment of the energy conservation center are desired for the time being. 4 refs.

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 5518, 6038

2960 Electric Power

Refer also to citation(s) 5548, 6033, 6035, 6036, 6038, 6039, 6135

6054 (CONF-9403188–, pp. 195-201) **Electric utility business and related issues in Japan.** Nagaya, S. (Kansai Electric Power Co. Inc., Osaka (Japan)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy Consultation, Mr. Nagaya from the Kansai Electric Power Co., Inc. lectured on the perspective of supply and demand for electric power and its issues, and deregulation in the electric utility business area. For the perspective of demand for electric power, the increase rate for the past ten years was the average in the 4% mark and the annual growth will be the average of 2% for the 10 - 20 years to come. To accommodate this high growth rate, power resources for about 84 million KW must be developed in Japan in the next ten years. To locate a powers plant, a very important issue must be settled: to secure the consent from the community. In particular, locating a nuclear power station is delayed, which forces thermal power generation to be increased by utilizing coal and LNG. When more fossil fuel is consumed, more problems take place with global environments. This raises a new issue of enhancing efficiency in supply. Deregulation of electricity business may enable introducing and using of electric power from distributed sources and reducing of the electric power charge through new entry into the power generation area. The possible effects of deregulation are being discussed. The Kansai Electric Power Co.,Inc. will take this as a chance of increasing the administrative efficiency for future success.

6055 (CONF-9403188–, pp. 202-209) **Overview of the U.S. electric industry.** Anthony, E. (Edison Electric Institute, (United States)). Institute of Energy Economics, Tokyo (Japan). Jul 1994. 249p. (In Japanese). From U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994. In *U.S.-Japan Energy Conference/Maui Meeting.* Order Number DE95730205. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

At Maui Meeting of the U.S.-Japan Energy Consultation, Mr. Anthony, vice-Chairman of the Edison Electric Association, lectured on the latest state of the U.S. electric utility business and its perspective. The annual growth of the demand for electric power in the U.S.A. had been the average of 2% for the past five years or more. In 1993, the rate may be 3.4%. The annual growth from 1992 - 2000 is estimated to be the average of 2.6%. The U.S.A. is in process of executing the 1992 Energy Policy Act that opens the power transmission system to wholesale transactions in order to make bulk electric power supply more competitive. Some consider this to be a large change made to the nature of the traditional electricity business. To adapt to the environmental issues of the Earth, the Association successfully opposed the energy tax that would cover a wide range of energies through the EEI, and could prevent the cost rise of as much as $8 billion per year. New entries to electricity business may include electric cars and cable space that can enter the telecommunications area.

6056 (CONF-9408169–1) **David and the Goliaths: How a small environmental group helps reform electric-utility regulation.** Hirst, E. (Oak Ridge National Lab., TN (United States)); Swanson, S. Oak Ridge National Lab., TN (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From American Council for Energy-Efficient Economy (ACEEE) summer conference; Asilomar, CA

(United States); 28 Aug - 3 sep 1994. Order Number DE94017708. Source: OSTI; NTIS; GPO Dep.

In 1991 the Land and Water Fund of the Rockies (LAW Fund), a regional environmental organization, started an Energy Project with two lawyers and a scientist to challenge the energy-efficiency, renewable-resource and environmental-protection practices of utilities in the vast six-state Rocky Mountain region. Within three years, Colorado and Utah had adopted comprehensive integrated resource planning (IRP) rules, and several utilities had developed plans to expand their demand-side management (DSM) activities. The authors discuss the role that this small band of lawyers and policy analysts played in stimulating these changes, based on their first-hand experience with the LAW Fund. They also comment on the substantial influence and valuable services that such a small group can provide.

6057 (DOE/EIA–0095(93)) **Inventory of power plants in the United States, 1993.** USDOE Energy Information Administration, Washington, DC (United States). Office of Coal, Nuclear, Electric and Alternate Fuels. Dec 1994. 388p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004720. Source: OSTI; NTIS; GPO; INIS; GPO Dep.

The Inventory of Power Plants in the United States is prepared annually by the Survey Management Division, Office of Coal, Nuclear, Electric and Alternate Fuels, Energy Information Administration (EIA), U.S. Department of Energy (DOE). The purpose of this publication is to provide year-end statistics about electric generating units operated by electric utilities in the United States (the 50 States and the District of Columbia). The publication also provides a 10-year outlook of future generating unit additions. Data summarized in this report are useful to a wide audience including Congress, Federal and State agencies, the electric utility industry, and the general public. Data presented in this report were assembled and published by the EIA to fulfill its data collection and dissemination responsibilities as specified in the Federal Energy Administration Act of 1974 (Public Law 93-275) as amended.

6058 (ETDE/DE-mf–95726049) **Major energy users and reforms of the German energy industry.** Wirtschaftswissenschaftliche Diskussionsbeitraege, v. V-138-94. Pfaffenberger, W. Oldenburg Univ. (Germany). Inst. fuer Volkswirtschaftslehre (VWL). Jun 1994. 14p. Order Number DE95726049. Source: OSTI; NTIS (US Sales Only).

There is a historic tradition of industrial autoproduction of electricity in Germany. Major energy users in the past used to be and today often still are autoproducers of electric power. The public utility sector, according to present legal standards, operates in a framework that protects local and regional monopolies. The large consumers and autoproducers are an important countervailing power in the whole system of the electricity supply industry. Electric utilities (EU) in Germany are semi-public or private enterprises of a wide variety of size. The large producer utilities operate the high voltage grid on the basis of private contracts. Regional distribution companies mostly without a considerable share in production often in cooperation with local distributors deliver electricity (el) in the non-urban areas whereas mostly city owned EU supply the large cities often on the basis of considerable parts of autoproduction and often also with a considerable share of el produced in cogeneration plants. The equilibrium between the parts of this system in the past was ensured by a legal framework protecting local monopolies as well as long term contracts between producers and distributors. Deregulation trends inherent in European legislation on competition have threatened this stability. In the first phase resistance against a more competitive order seemed unanimous. In the meantime however the different actors had time to rethink their position: The European Council has now proposed a more moderate regulation. The German Government has made a proposal for some important changes in the Energy Law and connected passages in the Competition Law, which would introduce some more competitive elements into the system without anticipating the results of a competitive process.

6059 (ETDE/DE-mf–95726054) **Electricity regulation in Germany - in the context of the European market.** Wirtschaftswissenschaftliche Diskussionsbeitraege, v. V-137-94. Pfaffenberger, W. Oldenburg Univ. (Germany). Inst. fuer Volkswirtschaftslehre (VWL). Jun 1994. 18p. Order Number DE95726054. Source: OSTI; NTIS (US Sales Only).

Electric utilities (EU) in Germany are semi-public or private enterprises of a wide variety of size. The large producer utilities operate the high voltage grid on the basis of private contracts. Regional distribution companies mostly without a considerable share in production often in cooperation with local distributors deliver electricity (el) in the non-urban areas whereas mostly city owned EU supply the large cities often on the basis of considerable parts of autoproduction and often also with a considerable share of el produced in cogeneration plants. The equilibrium between the parts of this system in the past was ensured by a legal framework protecting local monopolies as well as long term contracts between producers and distributors. This equilibrium derived its stability from political more than from economic factors. Deregulation trends inherent in European legislation on competition have threatened this stability. - In the first phase resistance against a more competitive order seemed unanimous. In the meantime however the different actors had time to rethink their position. - The European Council has now proposed a more moderate regulation taking into account the large differences in the ESI in the different member countries. - The German Government has made a proposal for some important changes in the Energy Law and connected passages in the Competition Law, which would introduce some more competitive elements into the system without anticipating the results of a competitive process. - Wholesale producers and regional distributors as well as customer groups are in favour of this reform, whereas the local distributors fear to become the losers in the ongoing reform process. - Environmentalists express concern that a more competitive order could lead to a lowering of environmental standards. This paper gives a short survery of the ESI in Germany, its regulations and the ongoing reform. (orig.)

6060 (ETDE/DE-mf–95726788) **Municipal energy concepts: Financial incentives and supportive actions of government of the Land Hesse.** Schweer, R. Ministerium fuer Umwelt, Energie und Bundesangelegenheiten des Landes Hessen, Wiesbaden (Germany). 1994. 76p. (In German). Order Number DE95726788. Source: OSTI; NTIS (US Sales Only).

The climate protection and energy policy of the Hessian government supports the demands of the enquete commission of the Bundestag to reduce the CO_2-emission by 30% until the year 2010 in order to protect the earth atmosphere. This is achieved by legal measures, support of investment measures and by testing of new organisation and financing models e.g. the Contracting of the Hessian energy agency "Hessen-Energie GmbH" that was founded in 1991. In Hesse the support of a rational and environmentally harmless use of energy is provided on the basis of the Hessian Energy Law (Hessisches Energiegesetz, HEnG) of 25th May 1990. The support shall help to achieve the following aims: - Climate protection; - Thoughtful use of the resources; - Improvement of the efficiency; - Introduction into the market; - Information and qualification. In 1994 the budgetary funds and Verpflichtungsermaechtungen for investive information and qualification projects provide 95 million DM for the energy section. (orig.)

6061 (ETDE/DE-mf–95733242) **PreussenElektra. Annual report 1992.** Preussische Elektrizitaets-AG (Preussenelektra), Hannover (Germany). 1993. 99p. (In German). Order Number DE95733242. Source: OSTI; NTIS (US Sales Only).

The tasks and activities of this big German affiliated company are reviewed. The 1992 annual report contains many financial data, e.g. balance sheet, profit-and-less account, etc. The company constructs, buys, and sells plants for supplying consumers with electric power, gas, heat, and water. (UA)

6062 (ETDE/DE-mf–95733277) **VEBA business report 1992.** VEBA AG, Duesseldorf (Germany). 1993. 116p. (In German). Order Number DE95733277. Source: OSTI; NTIS (US Sales Only).

The tasks and activities of this large German multi-purpose company are described and numerous financial data (balance, statement of revenue and expenditure) is given in this annual report 1992. The company aims at setting up, operating and purchasing power-producing and distributing plants, of companies of the mining and metallurgical industry and of the chemical and

petroleum industry, of trading and shipping companies as well as of other companies. The society has also holdings in several companies of this fields. (orig./UA)

6063 (ETDE/DE-mf–95733298) **Energie-Versorgung Schwaben AG. Annual report 1992.** Energie-Versorgung Schwaben AG, Stuttgart (Germany). 1993. 55p. (In German). Order Number DE95733298. Source: OSTI; NTIS (US Sales Only).

The tasks and activities of this big German group member company (electricity, district heat, gas) are reviewed. The 1992 balance sheet contains a multitude of financial data (balance sheet, profit-and-loss account, etc.). The company is active in the production, transport and distribution of electricity, district heat and gas and in the construction, acquisition and operation of the facilities required for this. (UA)

6064 (ETDE/DE-mf–95733301, pp. 7-35) **Forecast of electric power consumption in East German mining and processing plants through 2005.** Matthies, J. Institut fuer Wirtschaftsforschung Halle (IWH) (Germany). Jul 1993. 90p. (In German). In *East German energy sector in upheaval. Pt. 3.* Order Number DE95733301. Source: OSTI; NTIS (US Sales Only).

This essay explores the development of energy consumption in East Germany, particularly in terms of the raw materials. Using inductive methods he deduces sound estimates, which are then aggregated to give the results set out here. In view of the central position of the electricity industry, comments are also included regarding the future demand for brown coal, the competition between oil, gas, coal and electricity and the implications of electricity and energy prices for the East German economy. (orig./UA)

6065 (ETDE/DE-mf–95733457) **Prospects: 25 years GOPA 1990.** Gesellschaft fuer Organisation, Planung und Ausbildung mbH (GOPA), Bad Homburg (Germany). 1990. 177p. (In German). Order Number DE95733457. Source: OSTI; NTIS (US Sales Only).

On the occasion of the 25th anniversary of the company promotion the GOPA issued this publication. It shows the varied field of action of the company. In individual articles employees comment on topical questions. They report about their experience and reflect gained knowledge. Articles on basic subjects are contained as well as descriptions of specific programs and projects. The increasing importance of environmental, resource, energy, employment and basic need problems can also be seen from the space taken by articles on these subjects which corresponds to their importance and topicality. Two energy-related subjects are dealt with: 1. Rational use of energy in the area of electricity, 2. use of renewable energy sources in developing countries. (orig./UA)

2980 Consumption and Utilization

Refer also to citation(s) 4993, 5984, 6035, 6037, 6038, 6114

6066 (DOE/EIA–0204(94/05)) **EIA new releases.** USDOE Energy Information Administration, Washington, DC (United States). Sep 1994. 26p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003447. Source: OSTI; NTIS; INIS; GPO; GPO Dep.

This report is a compliation of news releases from the Energy Information Administration. The september-october report includes articles on energy conservation, energy consumption in commercial buildings, and a short term energy model for a personal computer.

6067 (DOE/EIA–0587) **Energy use and carbon emissions: Non-OECD countries.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1994. 66p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004482. Source: OSTI; NTIS; GPO Dep.

This report surveys world energy use and carbon emissions patterns, with particular emphasis on the non-OECD countries. The non OECD is important not only because it currently makes up 84% of world population, but because its energy consumption, carbon emissions, population, and grow domestic product have all been growing faster than OECD's. This presentation has seven major sections: (1) overview of key trends in non-OECD energy use and carbon emissions since 1970; (2) Comparison and contrasting energy use and carbon emissions for five major non OEDC regions (former Soviet Union and eastern Europe, Pacific Rim including China, Latin America, other Asia; Africa; 3-7) presentation of aggregate and sectoral energy use and carbon emissions data for countries within each of the 5 regions.

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 5569, 5998, 6036

6068 (ETDE/DE-mf–95733457, pp. 59-64) **Use of renewable energy sources in developing countries. The energy-economical situation in rural areas.** Siegler, H.J.; Johnson, J.P. Gesellschaft fuer Organisation, Planung und Ausbildung mbH (GOPA), Bad Homburg (Germany). 1990. 177p. (In German). In *Prospects: 25 years GOPA 1990.* Order Number DE95733457. Source: OSTI; NTIS (US Sales Only).

In the comparative analysis of energy supply systems for rural areas in developing countries in this article the following energy supply alternatives are differentiated: - Use of renewable energy sources, - use of diesel-driven generators, - network supply. The use of renewable energy sources is first analyzed in connection with the self-generation of electricity in case of which water power, wind and solar energy substitute for conventional energy technologies or diesel generators. Then direct substitution competition between diesel engines and plants which use renewable energy sources are included in the analysis. Finally isolated supply structures used with renewable energy technologies are compared to central supply via regional or national networks. (orig.)

6069 (NEDO-P–9306) **Present development status of petroleum substitution energy (East Europe).** New Energy and Industrial Technology Development Organization, Tokyo (Japan). Mar 1994. 162p. (In Japanese). Order Number DE95723114. Source: OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan.

Overseas, particularly East European situation was investigated to effectively promote the development and introduction of oil-alternative energy for Japan. As an energy source in East Europe, coal and brown coal are mainly used, while recyclable energy is seldom utilized. After Chernobyl accident, ex-Yugoslavia and Poland are passive toward the nuclear power generation, while Bulgaria is positively making an investment in it. Poland mainly uses coal which is abundant in SO2 and NOx. Though conversion to oil is being groped for, interest is not heightened in energy recycling. In Hungary, oil and coal production tends to decrease. They make progress in diversification in order to be released from their dependency on the CIS. As new energy to be developed, Rumania studies the wind force, solar heat, geothermal and biomass. Bulgarian policy mainly consists in exploiting coal mines and developing the nuclear energy for the self-sustenance. Czecho and Slovakia are groping for the nuclear energy and diversification. Because of an decrease in oil importation from the CIS, all countries in East Europe must diversify the sources of energy supply. 9 refs., 12 figs., 80 tabs.

6070 (NEI-DK–1753) **Bio motor-fuels - draft for an experimental programme.** Energistyrelsen, Copenhagen (Denmark); Landbrugsministeriet, Copenhagen (Denmark); Landbrugsraadet, Copenhagen (Denmark); Miljoestyrelsen, Copenhagen (Denmark); Skatteministeriet, Copenhagen (Denmark); Trafikministeriet, Copenhagen (Denmark). Aug 1994. 40p. (In Danish). Order Number DE95723857. Source: OSTI; NTIS.

The overall aim of the planned programme is to gather knowledge and experience as a basis for Danish governmental decision-making on the financing of the future production and use of bio motor-fuels such as rape seed oil, ethanol and methane in order to live up to the national policy of reducing carbon dioxide emission. Aspects investigated are related to transport, agriculture, the environment, energy consumption, taxation and economics. Some of the main questions addressed are whether the use of

these fuels will actually reduce air pollution, are there enough biomass resources, which of these fuels are in all aspects the most promising, how can they find their place within the overall Danish fuel supply system, which technologies are technically and commercially ready and whether there is a basis for the commercial production of bio motor-fuels in Denmark. It is also considered important to evaluate the possibilities for improving production techniques and economies by subsidization, by taking part in international research, by improving information dissemination and coordinating research activities etc. (AB)

6071 (RUB-E–76) **Technical innovations and development perspectives of renewable energy sources. 9. Technical report on the research project: Analysis of possibilities of solar power supply and its development in Nordrhein-Westfalen.** Gernhardt, D.; Behrendt, F.; Mohr, M.; Skiba, M.; Unger, H. Bochum Univ. (Germany). Lehrstuhl fuer Nukleare und Neue Energiesysteme. Apr 1994. 161p. (In German). Contract IV B3-258 002. Order Number DE95726786. Source: OSTI; NTIS (US Sales Only).

This Ninth Technical Report of the study 'Analysis of Possibilities of Solar Power Supply and its Development in Nordrhein-Westfalen' describes technical innovations of renewable energy sources and shows intermediate and long-tem perspectives of development of renewable energy potentials. Research activities and technical innovations concerning equipment and fabrication are shown for solar passive systems, solar thermal and photovoltaic applications, biomass combustion and gasification and for wind generators. Also their future perspectives are discussed. To estimate the influences of different boundary conditions on the future development of renewable energy potentials, trends of population, suitable surfaces for solar applications and agricultural and forest activities are determined for Nordrhein-Westfalen and for four modelled municipalities. Final the absolute trends and trends related to the number of inhabitants of the intermediate and long-term development of renewable energy potentials, drawn from technical innovations and changing conditions, are estimated. (orig.)

30 DIRECT ENERGY CONVERSION

3001 MHD Generators

6072 (CONF-940780–Vol.2, pp. 613-619) **High performance materials in coal conversion/utilization.** Boss, W. (Univ. of Tennessee Space Institute, Tullahoma, TN (United States)); Dahotre, N.; Larue, P.; Xiao, C. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

This paper describes the research being conducted at the University of Tennessee Space Institute (UTSI) on high performance materials for use in corrosive coal fired environments. Particular attention has been given to the ceramic composite manufactured by Lanxide Corporation as a potential tubular component in a recuperative high-temperature air heater.

6073 (DOE/ET/10815–228) **Technical progress report for the magnetohydrodynamics coal-fired flow facility, July 1, 1994–September 30, 1994.** Tennessee Univ., Tullahoma, TN (United States). Space Inst. Oct 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-79ET10815. (UTSI–94-06). Order Number DE95003594. Source: OSTI; NTIS; GPO Dep.

In this quarterly technical progress report, UTSI reports on the status of a multi-task contract to develop the technology for the steam bottoming portion of a MHD Steam Combined Cycle Power Plant. The report describes the facility maintenance and environmental work completed, status of completing technical reports and certain key administrative actions occurring during the quarter. With current year budget reductions and program reductions to closeout the MHD program, downsizing of the UTSI work force was completed for FY94. No further testing occurred or was scheduled during the quarter, but the DOE CFFF facility was maintained in a standby status. Plans progressed for environmental actions needed at the site. Work began on archiving the results of the MHD program.

6074 (DOE/ID/12735–T33) **Projects at the Component Development and Integration Facility. Quarterly technical progress report, July 1–September 30, 1994.** MSE, Inc., Butte, MT (United States). [1994]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-88ID12735. Order Number DE95003832. Source: OSTI; NTIS; INIS; GPO Dep.

This quarterly technical progress report presents progress on the projects at the Component Development and Integration Facility (CDIF) during the fourth quarter of FY94. The CDIF is a major Department of Energy test facility in Butte, Montana, operated by MSE, Inc. Projects in progress include: Biomass Remediation Project; Heavy Metal-Contaminated Soil Project; MHD Shutdown; Mine Waste Technology Pilot Program; Plasma Projects; Resource Recovery Project; and Spray Casting Project.

6075 (DOE/PC/79672–T9) **MHD seed recovery and regeneration, Phase II. Final report.** TRW Space and Electronics Group, Redondo Beach, CA (United States). Oct 1994. 384p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-87PC79672. Order Number DE95004308. Source: OSTI; NTIS; GPO Dep.

This final report summarizes the work performed by the Space and Technology Division of the TRW Space and Electronics Group for the U.S. Department of Energy, Pittsburgh Energy Technology Center for the Econoseed process. This process involves the economical recovery and regeneration of potassium seed used in the MHD channel. The contract period of performance extended from 1987 through 1994 and was divided into two phases. The Phase II test results are the subject of this Final Report. However, the Phase I test results are presented in summary form in Section 2.3 of this Final Report. The Econoseed process involves the treatment of the potassium sulfate in spent MHD seed with an aqueous calcium formate solution in a continuously stirred reactor system to solubilize, as potassium formate, the potassium content of the seed and to precipitate and recover the sulfate as calcium sulfate. The slurry product from this reaction is centrifuged to separate the calcium sulfate and insoluble seed constituents from the potassium formate solution. The dilute solids-free potassium formate solution is then concentrated in an evaporator. The concentrated potassium formate product is a liquid which can be recycled as a spray into the MHD channel. Calcium formate is the seed regenerant used in the Econoseed process. Since calcium formate is produced in the United States in relatively small quantities, a new route to the continuous production of large quantities of calcium formate needed to support an MHD power industry was investigated. This route involves the reaction of carbon monoxide gas with lime solids in an aqueous medium.

3003 Thermoelectric Generators

Refer also to citation(s) 5507

6076 (NEI-DK–1760) **AMTEC thermo-electric conversion. Final report.** Christensen, H. Innovision A/S, Odense (Denmark). Oct 1994. 35p. (In Danish). Contract ENS-1443/91-0003. Order Number DE95723862. Source: OSTI; NTIS.

EFP-91.

The aim was to gain experience on how to produce Alkali Metal Thermo-Electric-Converter (AMTEC) cells, for the demonstration of their principles and potentials, as a basis for future commercialization. These cells should be able to present an efficient and direct conversion of thermal energy to electric energy. The system is based on an electro-chemical concentration cell built around a β'' aluminium oxide membrane that separates the two chambers. This material is a good conductor of sodium and a bad conductor of electrons, and it is this property which is taken advantage of. In the two chambers of the cell is found saturated sodium vapour at two

temperatures. The motive power is the expansion over the membrane where the sodium ions are transported through it whilst the electrons are forced through the outer cycle. This concept is described in detail in addition to the choice of materials, performance testing and results. It was found possible to produce AMTEC electrodes via serigraphic feeding. The strengths and weaknesses of the finished product are illuminated. (AB) (10 refs.)

3005 Fuel Cells

Refer also to citation(s) 5516, 5517, 5519, 5682, 5684, 6227, 6228

6077 (ANL/CMT/CP–84099) **Liquid-fueled SOFC power sources for transportation.** Myles, K.M.; Doshi, R.; Kumar, R.; Krumpelt, M. Argonne National Lab., IL (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9410170–2: 1. European solid oxide fuel cell forum: engineering, systems, applications, Lucerne (Switzerland), 3-7 Oct 1994). Order Number DE95002998. Source: OSTI; NTIS; GPO Dep.

Traditionally, fuel cells have been developed for space or stationary terrestrial applications. As the first commercial 200-kW systems were being introduced by ONSI and Fuji Electric, the potentially much larger, but also more challenging, application in transportation was beginning to be addressed. As a result, fuel cell-powered buses have been designed and built, and R&D programs for fuel cell-powered passenger cars have been initiated. The engineering challenge of eventually replacing the internal combustion engine in buses, trucks, and passenger cars with fuel cell systems is to achieve much higher power densities and much lower costs than obtainable in systems designed for stationary applications. At present, the leading fuel cell candidate for transportation applications is, without question, the polymer electrolyte fuel cell (PEFC). Offering ambient temperature start-up and the potential for a relatively high power density, the polymer technology has attracted the interest of automotive manufacturers worldwide. But the difficulties of fuel handling for the PEFC have led to a growing interest in exploring the prospects for solid oxide fuel cells (SOFCs) operating on liquid fuels for transportation applications. Solid oxide fuel cells are much more compatible with liquid fuels (methanol or other hydrocarbons) and are potentially capable of power densities high enough for vehicular use. Two SOFC options for such use are discussed in this report.

6078 (DOE/CE/50343–2) **Multi-fuel reformers for fuel cells used in transportation. Multi-fuel reformers: Phase 1 – Final report.** Little (Arthur D.), Inc., Cambridge, MA (United States). May 1994. 122p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-92CE50343. Order Number DE95004215. Source: OSTI; NTIS; GPO Dep.

DOE has established the goal, through the Fuel Cells in Transportation Program, of fostering the rapid development and commercialization of fuel cells as economic competitors for the internal combustion engine. Central to this goal is a safe feasible means of supplying hydrogen of the required purity to the vehicular fuel cell system. Two basic strategies are being considered: (1) on-board fuel processing whereby alternative fuels such as methanol, ethanol or natural gas stored on the vehicle undergo reformation and subsequent processing to produce hydrogen, and (2) on-board storage of pure hydrogen provided by stationary fuel processing plants. This report analyzes fuel processor technologies, types of fuel and fuel cell options for on-board reformation. As the Phase 1 of a multi-phased program to develop a prototype multi-fuel reformer system for a fuel cell powered vehicle, the objective of this program was to evaluate the feasibility of a multi-fuel reformer concept and to select a reforming technology for further development in the Phase 2 program, with the ultimate goal of integration with a DOE-designated fuel cell and vehicle configuration. The basic reformer processes examined in this study included catalytic steam reforming (SR), non-catalytic partial oxidation (POX) and catalytic partial oxidation (also known as Autothermal Reforming, or ATR). Fuels under consideration in this study included methanol, ethanol, and natural gas. A systematic evaluation of reforming technologies, fuels, and transportation fuel cell applications was conducted for the purpose of selecting a suitable multi-fuel processor for further development and demonstration in a transportation application.

6079 (DOE/MC/29224–3931) **Processing of $LaCrO_3$ for solid oxide fuel cell applications.** Huebner, W.; Anderson, H.U. Missouri Univ., Rolla, MO (United States). Sep 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG21-93MC29224. Order Number DE95000024. Source: OSTI; NTIS; GPO Dep.

The University of Missouri-Rolla is performing a 5 year research program dedicated towards the development of $LaCrO_3$-based interconnect powders which densify when in contact with anode and cathode materials for solid oxide fuel cells (SOFC). During the course of this program the authors investigated compositions within the pseudo-ternary $LaCrO_3$-$LaMnO_3$-$LaCoO_3$ system. Their expanded studies on the processing and sintering of $LaCrO_3$ to make dense interconnects using $LaCrO_3$-based oxides at temperatures less than 1,500 C in an air atmosphere and in contact with both anode and cathode oxides. The specific objectives of this research program are to: Develop a novel technique which reproducibly yields $LaCrO_3$-based powders with the desired particle characteristics; Fully understand the liquid phase sintering mechanism; Clearly identify the reason why $LaCrO_3$ does not densify in the presence of electrolyte and cathode materials; Systematically solve this problem through judicious control over the liquid phase; and Incorporate materials developed in this program into planar cells and measure their performance. Results are discussed on porosity and skrinkage, and sintering and melting behaviors.

6080 (DOE/METC–94/1002, pp. 93) **Summary-natural gas fuel cells and natural gas turbines.** Langan, W.T. USDOE Morgantown Energy Technology Center, WV (United States). Nov 1993. (CONF-931156–: Fuels technology contractors' review meeting, Morgantown, WV (United States), 16-18 Nov 1993). In *Proceedings of the fuels technology contractors review meeting.* 568p. Order Number DE94004065. Source: OSTI; NTIS.

Two major programs are being conducted to demonstrate cost-effective, energy efficient, and low environment emission systems for power generation and industrial applications utilizing natural gas as a fuel source. These are the Fuel Cell Program and the Advanced Turbine Systems Program.

6081 (DOE/METC–94/1010) **Proceedings of the fuel cells '94 contractors review meeting.** Carpenter, C.P. II (USDOE Morgantown Energy Technology Center, WV (United States)); Mayfield, M.J. (eds.). USDOE Assistant Secretary for Fossil Energy, Washington, DC (United States); USDOE Morgantown Energy Technology Center, WV (United States). Aug 1994. 191p. Sponsored by USDOE, Washington, DC (United States). (CONF-940883–: Fuel cells '94, Morgantown, WV (United States), 17-19 Aug 1994). Order Number DE94012285. Source: OSTI; NTIS; GPO Dep.

METC annually sponsors this conference to provide a forum for energy executives, engineers, etc. to discuss advances in fuel cell research and development projects, to exchange ideas with private sector attendees, and to review relevant results in fuel cell technology programs. Two hundred and three people from industry, academia, and Government attended. The conference attempts to showcase the partnerships with the Government and with industry, by seeking activity participation and involvement from the Office of Energy Efficiency and Renewable Energy, EPRI, GRI, and APRA. In addition to sessions on fuel cells (solid oxide, molten carbonate, etc.) for stationary electric power generation, sessions on US DOE's Fuel Cell Transporation Program and on DOD/APRA's fuel cell logistic fuel program were presented. In addition to the 29 technical papers, an abstract of an overview of international fuel cell development and commercialization plans in Europe and Japan is included. Selected papers were indexed separately for inclusion in the Energy Science and Technology Database.

6082 (NEI-FI–248, pp. 131-135) **Solid polymer electrolytes for fuel cells.** Sundholm, F. (Helsinki Univ. (Finland). Dept. of Polymer Chemistry); Kinnunen, J. Helsinki Univ. of Technology, Otaniemi (Finland). 1993. (CONF-9303322–: 1. Nordic symposium

on hydrogen and fuel cells for energy storage, Espoo (Finland), 11-12 Mar 1993). In *Hydrogen and fuel cells for energy storage.* 166p. Order Number DE95723907. Source: OSTI; NTIS.

Short communication SOLID ELECTROLYTE FUEL CELLS/ organic polymers; SOLID ELECTROLYTE FUEL CELLS/ performance; SOLID ELECTROLYTES; PERFORMANCE; MEMBRANES; ELECTRODES; SYNTHESIS

6083 (NREL/TP–463-6831) **Environmental, health, and safety issues of fuel cells in transportation. Volume 1: Phosphoric acid fuel-cell buses.** Ring, S. National Renewable Energy Lab., Golden, CO (United States). Dec 1994. 85p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000289. Source: OSTI; NTIS; GPO Dep.

The U.S. Department of Energy (DOE) chartered the Phosphoric Acid Fuel-Cell (PAFC) Bus Program to demonstrate the feasibility of fuel cells in heavy-duty transportation systems. As part of this program, PAFC- powered buses are being built to meet transit industry design and performance standards. Test-bed bus-1 (TBB-1) was designed in 1993 and integrated in March 1994. TBB-2 and TBB-3 are under construction and should be integrated in early 1995. In 1987 Phase I of the program began with the development and testing of two conceptual system designs- liquid- and air-cooled systems. The liquid-cooled PAFC system was chosen to continue, through a competitive award, into Phase H, beginning in 1991. Three hybrid buses, which combine fuel-cell and battery technologies, were designed during Phase III. After completing Phase II, DOE plans a comprehensive performance testing program (Phase HI) to verify that the buses meet stringent transit industry requirements. The Phase III study will evaluate the PAFC bus and compare it to a conventional diesel bus. This NREL study assesses the environmental, health, and safety (EH&S) issues that may affect the commercialization of the PAFC bus. Because safety is a critical factor for consumer acceptance of new transportation-based technologies the study focuses on these issues. The study examines health and safety together because they are integrally related. In addition, this report briefly discusses two environmental issues that are of concern to the Environmental Protection Agency (EPA). The first issue involves a surge battery used by the PAFC bus that contains hazardous constituents. The second issue concerns the regulated air emissions produced during operation of the PAFC bus.

6084 (ORNL/FMP–94/1, pp. 71-78) **Advanced materials, electrochemical studies, and electrochemical catalysis studies for solid oxide fuel cells.** Armstrong, T.R. (Pacific Northwest Lab., Richland, WA (United States)); Bates, J.L.; Pederson, L.R.; Raney, P.J.; Stevenson, J.W.; Weber, W.J. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC06-76RL01830. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Lattice expansion, phase stability, and oxygen permeation behavior of interconnect materials, particularly the lanthanum calcium chromites and the lanthanum strontium chromites, have been examined over a wide range of temperatures and oxygen partial pressures. In an operating solid oxide fuel cell, the interconnect must be stable in both oxidizing and reducing environments. Under reducing conditions, below approximately 10^{-10} atm. oxygen partial pressures, oxygen vacancies can be created depending on the temperature and the extent of strontium or calcium substitution for lanthanum. Reduction caused a substantial increase in the unit cell volume and isothermal linear expansion behavior. For $La_{0.70}Ca_{0.30}CrO_3$, the isothermal linear expansion change at 1000°C was 0.3 percent in Ar-4% H_2-3% H_2O referenced to air. Reduction followed by re-oxidation of the chromites was accompanied by a segregation of a calcium-rich phase to the grain boundary surfaces and microcracking, with a significant loss in mechanical strength as well as electrical conductivity. Oxygen permeation rates through sintered lanthanum were below 0.05 sccm/ cm^2 for 3 mm-thick disks. This small oxygen flux may serve to maintain the interconnect at oxygen partial pressures above those where deleterious reactions can occur.

6085 (ORNL/FMP–94/1, pp. 89-96) **Advanced electrolytes and synthesis of advanced catalysts and membrane materials.** Armstrong, T.R. (Pacific Northwest Lab., Richland, WA (United States)); Bates, J.L.; Coffey, G.W.; Kingsley, J.J.; Pederson, L.R.; Stevenson, J.W.; Weber, W.J.; Youngblood, G.E. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC06-76RL01830. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Mixed conductors in the lanthanum strontium cobalt chromium iron oxide system and protonic conductors in the strontium ytterbium cerate system are being evaluated for possible use in gas separation and purification, as electrolytes and electrodes in solid oxide fuel cells, and as sensors. Recent activities include materials synthesis, sintering behavior studies and microstructural characterization, development of methods to prepare novel shapes, electrical property characterization, and permeation testing. Single-phase LaSrCoCrFe oxides, being investigated for use as dense oxygen separation membranes, have been prepared by combustion methods. Sintering conditions were developed to obtain full density. The addition of up to 10 mole percent chromium, intended to improve the stability in a reducing environment, also significantly enhanced densification via liquid phase sintering. Compositions having a high A-site strontium content (80% or greater) were susceptible to internal cracking during cooling, due to large changes in oxygen stoichiometry. These are highly (mixed) conductive materials, with activation energies for conduction in the 0.08 to 0.17 eV range and conductivities to more than 500 S/cm. Passive oxygen fluxes varied with temperature, composition, and the oxygen concentration gradient. Protonic conductivity in these materials requires the presence of water, which reacts with oxygen vacancies to yield hydroxyl groups that support proton conduction. Transference numbers were determined for protons, oxygen ions, and electrons as a function of temperature. Protonic conduction dominated in hydrated cerates up to 450°C. At higher temperatures, oxygen ion and electronic conductivity became progressively more important. Hydrogen could be pumped across the cerate membrane by applying a dc voltage. At 800°C, pure hydrogen fluxes greater than 1 sccm/cm^2 could be driven across the membrane.

6086 (ORNL/FMP–94/1, pp. 155-162) **Advanced ceramic materials and electrochemical processes at interfaces.** Armstrong, T.R. (Pacific Northwest Labs., Richland, WA (United States)); Bates, J.L.; Pederson, L.R.; Stevenson, J.W.; Windisch, C.F. Jr. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC06-76RL01830. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The overall purpose of this effort is to develop new ceramic materials for use as electrolytes, electrodes, and interconnects in solid oxide fuel cells and related devices; to identify primary features in solid oxide fuel cell operation that would limit system performance; to evaluate mechanical, structural and chemical stabilities of fuel cell materials; and to develop novel materials synthesis and processing methodologies to improve the quality and lower the cost of solid oxide fuel cell manufacture. Interactions between the zirconia electrolyte and manganite cathode materials have been investigated. Such interactions are of interest because they may lead to changes in the cathode/electrolyte interfacial resistance. Interdiffusion profiles and diffusion coefficients were determined for electrolyte/electrode couples that had been sintered at temperatures from 1300 to 1500°C, similar to processing conditions necessary in the fabrication of some fuel cell designs. Manganese ions were found to be the most mobile species in zirconia, while lanthanum was the least mobile. Manganese penetration into the electrolyte was greatest for manganese-rich (A-site deficient) compositions and was favored by high level of substitution of calcium or strontium ions for lanthanum. The formation of interfacial lanthanum zirconate, and insulating phase, was not observed at the interface of zirconia and stoichiometric or A-site deficient manganites.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

Refer also to citation(s) 5971, 5973, 6032, 6034

6087 (IEE-SR–255) **Investigation on influences of large-scale power service interruption in life and economy in the Tokyo metropolitan region.** Institute of Energy Economics, Tokyo (Japan). Jun 1994. 238p. (In Japanese). Order Number DE95730202. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

Investigation and study are made on influences of large-scale power service interruption over life, society and economy in the Tokyo metropolitan region. The area of service interruption covers Tokyo Metropolis and Prefectures of Kanagawa, Saitama and Chiba, and approximately 11.5 million households or 32 million people. Presumed for study is a case where the service interruption will continue for three days starting 1300 hours on Monday in late August, and during those three days the interruption will be restored by 1/3 a day. As for home life, households are largely affected not only by home electric appliances not in operation, but by malfunction of social infrastructure: interruption of water and city gas supply in cooking, paralyzation of mass media in telecommunication, paralyzation of trains in moving, difficult food storage, closure of banks and supermarkets in the consumer section, and also malfunction of the police, fire service and medical facilities affecting safety, sanitation and existence. In economical evaluation, simulation on those effects is conducted, and in macro evaluation, the amount of the damage caused by service interruption is estimated approximately 1.8 trillion yen per year. 126 refs., 63 figs., 109 tabs.

3201 Buildings

Refer also to citation(s) 4966, 4970, 4971, 4972, 4973, 4974, 6136, 7024, 7025, 7026, 7027, 7028, 7029, 7030, 7031, 7043, 7044

6088 (AUC-IBT-R–9403) **Velocity distribution in a room with displacement ventilation and low-level diffusers.** Nielsen, P.V. Aalborg Universitetscenter (Denmark). Inst. for Bygningsteknik. Feb 1994. 23p. Order Number DE95723847. Source: OSTI; NTIS.

The article describes experiments with wall-mounted air terminal devices. The airflow from an air terminal device will influence the occupants' thermal comfort and it is therefore important to develop an expression for this flow. The velocity at the floor is influenced by the flow rate to the room, by the temperature difference and the type of diffuser. The flow is stratified at large temperature differences. The article shows the development of a semi-analytical expression for the velocity distribution in the vicinity of the floor. It is shown that openings between obstacles placed direct on the floor will generate a flow similar to the air movement in front of a diffuser. A semi-analytical equation for the velocity distribution is also given in the article. (au) (13 refs.)

6089 (AUC-IBT-R–9404) **Investigation of airflow in a room with displacement ventilation by means of a CFD-model.** Jacobsen, T.V.; Nielsen, P.V. Aalborg Universitetscenter (Denmark). Inst. for Bygningsteknik. Feb 1994. 23p. Order Number DE95723851. Source: OSTI; NTIS.

The airflow in front of an inlet device in a room with displacement ventilation is investigated in this study. In continuation of the full-scale measurements and the development of a CFD-model, this report aims at testing the model and conducting numerical experiments to provide a detailed description of the air current along the floor. It is investigated if the model results comply with a theoretical model. (au)

6090 (CONF-940780–Vol.2, pp. 639-646) **Extension of the central district heating system.** Selig, M.A. (Shooshanian Engineering Associates, Inc., Boston, MA (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

It is generally agreed that centralized district heating systems, when coupled with electricity generation (cogeneration), represent one of the most energy efficient approaches to providing space and process heat in urban areas. Centralization in turn affords the opportunity to cost-effectively limit emissions. Minimized primary fuel consumption and maximized pollution control makes expanding the use of district heat a very desirable approach toward urban air quality improvement. The planned DOE-supported project addresses Pilot Project 1 of the Krakow Clean Fossil Fuels and Energy Efficient Program - extension of the central station district heating system into the Koniewa area, to eliminate local boiler houses. This Project Area is considered by most to be the most cost-effective area within the DOE/Krakow program. The project will be particularly effective because the large boilers to be eliminated are antiquated, with very low-quality particulate removal systems. Moreover, unlike other areas of the city, Koniewa is relatively open and easy to work in, and many of the institutions to be converted to district heat are centrally owned and/or operated, reducing administrative difficulties.

6091 (CONF-940780–Vol.2, pp. 651-657) **The Krakow Low Emissions Coal Briquette Project.** Natschke, D.F.; Jozewicz, W. USDOE Pittsburgh Energy Technology Center, PA (United States). [1994]. From 10. annual coal preparation, utilization and environmental control contractors conference; Pittsburgh, PA (United States); 18-21 Jul 1994. In *Tenth annual coal preparation, utilization, and environmental control contractors conference: Proceedings. Volume 2.* 349p. Order Number DE94017536. Source: OSTI; NTIS; GPO Dep.

Krakow, the third largest city in Poland, is severely polluted because of a vigorous expansion program during the 1950s, transboundary pollution from the upper Silesia region, and a heavy reliance on coal for heat. In large part, Krakow is heated by district heating systems, small boiler houses, and residential stoves. Surveys conducted by the US Department of Energy (DOE) have found that there are 100,000 residential stoves burning approximately 132,000 tons of coal each year. Though small individually, residential stoves are significant contributors to Krakow's pollution. DOE estimates that 68 percent of emitted hydrocarbons are produced by residential stoves.

6092 (DOE/CH/10093–251) **Brayton-cycle solvent recovery heat pump. A technical brief.** National Renewable Energy Lab., Golden, CO (United States); Energetics, Inc., Columbia, MD (United States). Nov 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093 ; AC01-87CE40762. Order Number DE94000225. Source: OSTI; NTIS; GPO Dep.

The US Department of Energy's (DOE's) Office of Industrial Technologies (OIT) sponsors research and development (R & D) to improve the energy efficiency of American industry and to provide for fuel flexibility. Working closely with industry, OIT has successfully developed more than 50 new technologies that saved industry approximately 80 trillion Btu (84 quadrillion joules) of energy in 1992. More than 200 other projects are in various stages of development from laboratory research to field tests. The use of solvents in the industrial sector is widespread and results in the emission of volatile organic compounds (VOCs) to the atmosphere. These VOC emissions represent an economic loss to industry and contribute significantly to air pollution. To comply with increasingly strict environmental regulations while keeping costs down, industry must find efficient and cost-effective ways to control emissions from solvent use.

6093 (DOE/CH/10093–332) **Advances in glazing materials for windows.** National Renewable Energy Lab., Golden, CO (United States). Nov 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95004710. Source: OSTI; NTIS; GPO Dep.

No one type of glazing is suitable for every application. Many materials are available that serve different purposes. Moreover, consumers may discover that they need two types of glazing for a

home because of the directions that the windows face and the local climate. To make wise purchases, consumers should first examine their heating and cooling needs and prioritize desired features such as daylighting, solar heating, shading, ventilation, and aesthetic value. Research and development into types of glazing have created a new generation of materials that offer improved window efficiency and performance for consumers. While this new generation of glazing materials quickly gains acceptance in the marketplace, the research and development of even more efficient technology continues.

6094 (DTU-LV-MEDD–246) **Heating systems in low energy houses. A comparison related to energy and comfort.** Energiministeriets Forskningsprogram. Energianvendelse i bygninger. Engelund Thomsen, K.; Schultz, J.M.; Boye-Hansen, L. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. Apr 1994. 76p. (In Danish). Contract EM-1213-705-03-01; Contract EM-1213-605-02-01. Order Number DE95723852. Source: OSTI; NTIS.

EFP-87; EFP-86.

A number of heating systems and fresh air systems have been investigated in a highly insulated, low-energy, experimental building. The investigation included perimeter heating, radiator heating with the radiators placed under the windows, or separated from the thermal envelope, and forced hot air heating. Fresh air was taken either directly from the outside or through a crawl-space and was blown into the room with or wihtout preheating, either (a) 2 m above the floor and about 1,5 m from the outer wall, (2) near the ceiling over a window or (3) through three outlets at floor level. The energy consumption for achievement of the desired thermal conditions was evaluated. A computer program was developed to manage the data and calculations. The investigation showed that there was little difference between the systems in their ability to create and maintain satisfactory thermal comfort conditions. The evaluation is primarily based on whether the system kept the room within the limits for the PPD-index (Predicted Percentage Dissatisfied of the occupants) given in the international standard ISO 7730. Additionally the radiation asymmetry, the vertical temperature profile and the draught risk were analyzed and assessed. It was concluded that all the systems - including those where the heat sources were not placed next to the thermal envelope - performed satisfactorily regarding thermal comfort. Investigations confirmed that overheating is likely to occur in highly insulated buildings due to low heat losses and large solar gains - overheating may be limited or prevented by shading, screening or venting, but it is equally important that the heating system can respond quickly to changes in solar and internal gains and has no heat output when there is no actual demand. (AB) (15 refs.)

6095 (ETDE/DE-mf–95733213) **An energy conservation plan for Hanover. Hanover energy concept. Pt. 4. 4.1: Fundamentals and energy conservation for private households. 4.2: Energy conservation in municipal and public-assistance buildings.** Schriften zur Stadtentwicklung, v. 59. Stadt Hannover (Germany). Referatfuer Stadtentwicklung. Jul 1993. 142p. (In German). Order Number DE95733213. Source: OSTI; NTIS (US Sales Only).

In this publication, two partial areas of the energy saving plan are dealt with. After a discussion of fundamentals and problems, the first part treats the possibilities of energy saving and emission reduction for private households. The second part concern energy saving for buildings of the city and in social building construction. (UA)

6096 (ETDE/DE-mf–95733233) **Additional investment costs of low-energy house building. Actual costs of state-sponsored residential buildings in Hesse and Schleswig Holstein.** Eicke-Hennig, W. Institut Wohnen und Umwelt GmbH, Darmstadt (Germany). Jan 1993. 33p. (In German). Order Number DE95733233. Source: OSTI; NTIS (US Sales Only).

Low energy house building has been promoted financially in certain Laender for some years now. The present study makes an evaluation of the additional investment costs of low-energy house building by analysing the first complete accounts of residential buildings sponsored by the promotion campaigns of the Laender Hesse and Schleswig-Holstein. It becomes evident that the additional costs range between 3 and 8% of the basic costs. For houses with heat recovery plants (evaluated only for Schleswig-Holstein) they amount to 13-14%. (BWI)

6097 (ETDE/DE-mf–95733379) **Energy-saving construction and healthy living. A planning aid for builder owners, architects and engineers.** Ministerium fuer Wirtschaft, Mittelstand und Technologie des Landes Baden-Wuerttemberg, Stuttgart (Germany). Oct 1992. 96p. (In German). Order Number DE95733379. Source: OSTI; NTIS (US Sales Only).

Energy conservation measures in the area of buildings can considerably contribute to the planned reduction of CO_2 emissions particularly if they are not only carried out in the field of new buildings but also in existing buildings. In this booklet technical possibilites and bases of constructional thermal insulation in modern plant engineering are described in detail. In this connection the following subjects are gone into: Low-energy houses, bases of heat and humidity technology, correct heating and ventilating, thermal insulation of heating systems and water heaters, renewable energy sources, legal obligations, support possibilities, energy diagnosis and counselling. (BWI)

6098 (ETDE/DE-mf–95733384) **Extension of the actively solar heated single-family house at the Luebeck Polytechnic since 1982 for demonstration purposes by passive components and simultaneous increase of living comfort. Final report.** Weik, H. Fachhochschule Luebeck (Germany). Fachbereich Angewandte Naturwissenschaften. Feb 1993. 79p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0335011A. Order Number DE95733384. Source: OSTI; NTIS (US Sales Only).

For an extension of a research project with active solar thermal heating of a single-family house, a passive solar component in the form of a glass annexe was added. The two-storey part of the annexe makes it possible to conduct the heat via natural or forced circulation through the building and, by doing so, to also supply solar heat to rooms which are further apart from the annexe. Based on the experience gained in the last few years, the hydraulic tubing structure of the active solar system was fundamentally modified. A PC-controlled system was developed for controlling the complex heating system. Finally, a 3,2 kW PV generator with input to the network was installed, which makes the building a building with minimized energy consumption. The paper informs about the achieved results. (BWI)

6099 (ETDE/JP-mf–95729915) **Fundamental studies on design methods of circular reinforced concrete columns.** Nakata, H. (Osaka University, Osaka (Japan). Faculty of Engineering). Okumura Corp., Osaka (Japan). Jul 1994. 157p. (In Japanese). Order Number DE95729915. Source: OSTI; NTIS; Available from Okumura Corp., 2-2-2, Matsuzaki-cho, Abeno-ku, Osaka, Japan.

For the purpose of establishing design methods considering effects of shapes of the cross section of the circular reinforced concrete columns, made are elucidation of fundamental mechanical characteristics and proposal of various calculated equations of strength. From the experiment on flexural fracture of the RC circular column with circular spiral transverse reinforcing bar, it is found that the more the number of repeated loading, the smaller the toughness, and that even when receiving high axial force, the RC circular column with a full amount of transverse reinforcing bar does not break in the large deformation plastic zone where the angle of rotation of member is up to 1/30, if a total of 100 repeated loads are laid. In the ultimate strength design method, derived is the necessary calculated equation of accurate ultimate flexural strength of the cross section of the RC circular column without using the existing method. It is indicated that this calculated equation favorably infers the maximum flexural strength in obtained the serial analysis, and also that conformity to experimental values is equal to those obtained in the serial analysis. Further, in the experiment on unidirectional monotonic lateral loading under the fixed axial force and the experiment on the alternating repeated lateral loading, given is classification of shear modes of each specimen. 112 refs., 78 figs., 17 tabs.

6100 (KTH-EUV-KB--94-3) **Thermal comfort and sensation under transient conditions.** Wang, Xiaoling. Royal Inst. of Tech., Stockholm (Sweden). Dept. of Energy Technology. Nov 1994. 136p. (TRITA-EUV-R--1-94). Order Number DE95723982. Source: OSTI; NTIS.

This thesis consists of a study of thermal comfort under transient conditions. A thermo-regulatory model originally developed by the author has been developed further. The model can predict whether a subject is in a state of thermal comfort under a given set of transient conditions, and what the subject's thermal sensation will be. The model can also be used to estimate mean and segment skin temperatures, core temperatures, heat losses by radiation, convection and evaporation, and the heat storage rate in the human body. Experiments were carried out both with a full-scale thermal manikin and with human subjects. The manikin was used to determine convective heat transfer coefficients for various parts of the human body. The human subjects took part in a climate chamber experiment in which sweating, skin temperature and sensation were studied. Data from the manikin were used to develop the computer code. The experimental techniques with the manikin were used for studying the effects of various ventilation systems in vehicles. In the climate chamber experiments, sweating was studied by means of a noninvasive technique. A sensitive 'differential balance' was constructed to measure the small changes in total body weight that result from sweating. The skin temperatures were determined by using an infra- red camera. The results showed that the higher the relative humidity, the lower the skin temperatures were. The subjects recorded their thermal sensations during experiments. Thermal sensation varied in similar ways at different segments. The experimental techniques with the manikin have been applied to determine the most suitable ventilation system for bus drivers. The thermo-regulatory model was used to simulate the worst situation in both summer and winter. 156 refs., 76 figs., 29 tabs

6101 (LBL--36396) **Phase 2 of the California Healthy Building Study: A status report.** Fisk, W.J. (Lawrence Berkeley Lab., CA (United States). Energy and Environment Div.); Faulkner, D.; Mendell, M.J. Lawrence Berkeley Lab., CA (United States). Nov 1994. 33p. Sponsored by USDOE, Washington, DC (United States);National Inst. for Occupational Safety and Health, Rockville, MD (United States). DOE Contract AC03-76SF00098. Order Number DE95004819. Source: OSTI; NTIS; GPO Dep.

The primary goal of the California Healthy Building Study (CHBS) is to identify the major characteristics of buildings, ventilation systems, jobs, and indoor environmental quality that are associated with building-related sick-building health symptoms. The first phase of the CHBS was a cross sectional study of 12 office buildings located in the San Francisco Bay area. Health symptom and job data were collected via a questionnaire, buildings and ventilation systems were characterized, and regression models were used to assess associations between symptom prevalences and factors suspected to be associated with increased symptoms. This report summarizes research activities undertaken during Phase-2 of the CHBS and compiles currently available results. Phase 2 activities were limited to inspections and low cost measurements that yielded additional information that could be used in conjunction with the Phase-1 symptom data or provided valuable experience of information for future research. Because much of the Phase-2 effort was devoted to evaluation of measurement methodologies or collection of information that will be used in conjunction with the Phase-1 symptom data or provided valuable experience or information for future research. Because much of the Phase-2 effort was devoted to evaluation of measurement methodologies or collection of information that will be used in conjunction with the Phase-1 symptom data, this report is intended primarily for internal use by the CHBS research team.

6102 (LUTMDN-TMVK--5241) **Load management in one-family houses. Comparison between simulated and measured sequences.** Carlander, C. Lund Univ. (Sweden). Dept. of Heat and Power Engineering. Sep 1994. 99p. (In Swedish). Project BFR-870473-7. Order Number DE95723985. Source: OSTI; NTIS.

The aim of this study was to compare tsbi3-simulations with measured data. One-hour means were studied of the heating effects and the indoor temperatures in homes with direct electric heating and electric load control. The experiments comprised load management, nightly temperature boosts and heat disturbances. In the simulations, the house was zoned in two different ways, first with just one thermal zone, and then in seven different ones. The latter partitioning agreed better with the measured results. The agreement between measured and simulated data was generally good. When the indoor temperature falls, the difference was quite small, tenths of a centigrade. Raising temperature gave a greater difference, 1-1.5 C higher simulated temperature than measured, corresponding to a 1-1.5 kW higher heating effect. Differing control systems can explain part of this discrepancy. Another error stems from an underestimation of the insulating capacity of the windows. The main conclusion was that tsbi3 is well adapted to simulating the effects of load management discussed here.

6103 (NEI-DK--1739) **Handbook on energy control for civil servants who have responsibilities connected with energy.** Hagelskjaer, J. Energistyrelsen, Copenhagen (Denmark). Dec 1992. 97p. (In Danish). Order Number DE95723838. Source: OSTI; NTIS.

Control of energy usage is one of the best means of reducing energy consumption. The handbook presents guidelines for civil servants on how to save energy within their institutions. The concept of energy control, and methods of its initiation and administration, are explained. Ideas are given on how to formulate energy-saving goals leading to an energy conservation plan. Suggestions for the financing of energy control initiatives and energy saving activities are given in addition to examples of possible constraints and ways of overcoming them. Suggestions are given as to how to select energy-consuming consumer goods that have a low energy consumption rate and how to plan retrofitting or extension of buildings with the aim of obtaining facilities with a low consumption of energy. Training of personnel to be aware of energy reduction possibilities is dealt with, and examples are given how to inform employees on the aims and results of energy control. Conversion tables, a glossary, a list of abbreviations and examples of forms to be filled out etc. are included in the document.(AB)

6104 (NEI-NO--466) **Simplified methods in the estimation of the K-value of insulated cargo holds on ships.** Owusu-Achaw, K. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. Mar 1992. 109p. Order Number DE95723942. Source: OSTI; NTIS.

The problem of buried steelwork in cargo hold insulation has been investigated by several using empirical methods. These efforts have resulted in correction factors that serve as a useful aid in the complex task of estimating the K-value of a ship's cargo holds for the correct dimensioning of the refrigeration plant. Today, the advent of the digital computer has established numerical methods of analysis as a common working tool among practicing engineers. For estimating the flow in cases of buried steelwork that cannot be handled by correction factors, this is an effective approach. This study is an analytical/numerical investigation of the effect that buried steelworks have on the heat leakage across cargo hold walls. It aims at providing enlightenment on the physical significance of the parameters influencing the problem and developing practically simple methods for predicting the heat leakage across the hold walls. The study is set in the steady temperature in a rectangular layer of insulation, and investigates the mechanisms by which changes are caused in this temperature as a result of penetration by a steelwork. This approach is used to explain some known characteristics of buried steelwork in hold insulation and develop simple equations for estimating the heat leakage across hold boundaries. The calculation procedure due to Joelson, which has been found to predict heat flow rates reasonably, is reviewed and discussed. The accuracies of equations deduced from this study are compared with numerical solutions, Joelson's method and the correction factors developed by Bo Pierre using electrical analogue techniques. For practical estimation of a ship's K-value, the calculation procedures presented should be simple to work with. 23 refs., 27 figs., 11 tabs.

6105 (ORNL/CON--379) **Utility investments in low-income-energy-efficiency programs.** Brown, M.A. (Oak Ridge National Lab., TN (United States)); Beyer, M.A.; Eisenberg, J.; Power, M.; Lapsa, E.J. Oak Ridge National Lab., TN (United States). Sep 1994. 102p. Sponsored by USDOE, Washington, DC (United

States). DOE Contract AC05-84OR21400. Order Number DE95003393. Source: OSTI; NTIS; GPO Dep.

The objective of this study is to describe the energy-efficiency programs being operated by utilities for low-income customers. The study focuses, in particular, on programs that install major residential weatherization measures free-of-charge to low-income households. A survey was mailed to a targeted list of 600 utility program managers. Follow-up telephone calls were made to key non- respondents, and a random sample of other non-respondents also was contacted. Completed surveys were received from 180 utilities, 95 of which provided information on one or more of their 1992 low-income energy-efficiency programs for a total of 132 individual programs. These 132 utility programs spent a total of $140.6 million in 1992. This represents 27% of the total program resources available to weatherize the dwellings of low-income households in that year. Both the total funding and the number of programs has grown by 29% since 1989. A majority of the 132 programs are concentrated in a few regions of the country (California, the Pacific Northwest, the Upper Midwest, and the Northeast). Although a majority of the programs are funded by electric utilities, gas utilities have a significantly greater average expenditure per participant ($864 vs. $307 per participant). The most common primary goal of low-income energy-efficiency programs operating in 1992 was "to make energy services more affordable to low-income customers". Only 44% of the programs were operated primarily to provide a cost-effective energy resource. Based on a review of household and measure selection criteria, equity and not the efficiency of resource acquisition appears to dominate the design of these programs.

6106 (WHC-SD-GN-TRP--20014) **Load test of the 283W Clearwell Roof Deck and Support Structure.** McCoy, R.M. Westinghouse Hanford Co., Richland, WA (United States). 12 Sep 1994. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003865. Source: OSTI; NTIS; GPO Dep.

The 283W Clearwell roof area was load tested according to the approved load-test procedure, WHC-SD-GN-TP-30015, Revision 0, as modified below. The 283W Clearwell is located in the 200 West Area of the Hanford Site and has the following characteristics: Roof deck - concrete slab supported by columns and walls; Roof membrane - tar and gravel; Roof slope - flat (< 10 deg); and Roof elevation - approximately 6 in. above ground level. The 283W Clearwell was visited in April 1993 for a visual inspection, but could not be inspected because of the confined space requirements. It was revisited in February 1994 for the purpose of writing this test report. Because the roof could not be inspected, a test was determined to be the best way to qualify the roof for personnel access.

6107 (WHC-SD-GN-TRP--20025) **Load test of the 272W Building high bay roof deck and support structure.** McCoy, R.M. Westinghouse Hanford Co., Richland, WA (United States). 28 Sep 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003859. Source: OSTI; NTIS; INIS; GPO Dep.

This reports the results of the Load Test of the 272W Building High Bay Roof Deck and Support Structure.

3202 Transportation

Refer also to citation(s) 6083

6108 (ORNL--6840) **The productivity effects of truck size and weight policies: Final report.** Middendorf, D.P. (Oak Ridge National Lab., TN (United States). Center for Transportation Analysis); Bronzini, M.S. Oak Ridge National Lab., TN (United States). Nov 1994. 96p. Sponsored by USDOE, Washington, DC (United States);Federal Highway Administration, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95004222. Source: OSTI; NTIS; GPO Dep.

While previous studies have indicated that increases in truck size and weight limits could improve motor carrier productivity, the question of whether or not freight shippers will also benefit has not been adequately addressed. It is generally assumed that competitive conditions in the motor carrier industry will result in cost savings being passed to shippers in the form of lower freight rates. Transportation costs, however, are only one component of shipper total logistics cost. Warehousing cost, inventory holding cost, order processing cost, and other categories of business logistics cost may also change as a result of the less frequent but larger shipments typically associated with the use of longer combination vehicles (LCVs). If switching from single trailer truckload shipments to LCVs causes shipper non-transport logistics costs to increase more than the savings available from lower freight rates, then productivity gains may be lost to the firm and the economy as a whole. This research was undertaken to determine the net effect of truck size and weight policy changes on shipper total logistics cost and how these effects might influence the demand for alternative tractor-trailer configurations.

6109 (UCRL-JC--117938) **Analysis and optimization of an adsorption air conditioner for electric vehicle applications.** Aceves, S.M. Lawrence Livermore National Lab., CA (United States). 27 Jul 1994. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941142--25: American Society of Mechanical Engineers' winter annual meeting, Chicago, IL (United States), 9-11 Nov 1994). Order Number DE95003644. Source: OSTI; NTIS; GPO Dep.

This paper shows an analysis of the applicability of an adsorption system for electric vehicle (EV) air conditioning. Adsorption systems are designed and optimized to provide the required cooling for four combinations of vehicle characteristics and driving cycles. The resulting adsorption systems are compared with vapor compression air conditioners that can satisfy the cooling load. The objective function is the overall system weight, which includes the cooling system weight and the weight of the battery necessary to provide energy for air conditioner operation. The system with the minimum overall weight is considered to be the best. The results show the optimum values of all the variables, as well as temperatures and amounts adsorbed, for the adsorption and desorption processes. The results indicate that, for the conditions analyzed in this paper, vapor compression air conditioners are superior to adsorption systems, not only because they are lighter, but also because they have a higher COP and are more compact.

6110 (VTT-TIED--1569) **Traffic emissions in Russia and the Baltic States St. Petersburg, Leningrad Oblast, Republic of Karelia, Estonia, Latvia and Lithuania.** Maekelae, K. (VTT Communities and Infrastructure, Espoo (Finland). Transport Research); Salo, M. Technical Research Centre of Finland, Espoo (Finland). 1994. 50p. Order Number DE95723877. Source: OSTI; NTIS.

Exhaust gas emissions of traffic were examined in the areas of St.Petersburg, Leningrad Oblast, Republic of Karelia, Estonia, Latvia and Lithuania. The Following compounds were studied: carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), particles, sulphur dioxide (SO_2), lead (Pb) and carbon dioxide (CO_2). The traffic modes examined were road traffic, railway traffic, air traffic and waterway traffic. The emission calculations are based on mileage, cycles, fuel consumption and specific emissions. The base year of the calculations is 1992. This overall study of traffic emissions is the first of its kind in the area of the former Soviet Union. The city of St.Petersburg dominates in emissions, as was to be expected. The amount of emissions are quite well in proportion to population. Road traffic is by far the greatest emission source in total traffic emissions. Next are railway, waterway and air traffic. The year 1989 can be considered as a peak year in mileage and emissions in the area of the former Soviet Union. After that year, the political and economic changes significantly decreased the amount of mileage and emissions, especially in the Baltic States. Probably the minimum year for traffic emissions is the base year of this study, 1992. In Estonia, emissions were halved compared with 1989. In Russia the decrease was not so big

3203 Industrial and Agricultural Processes

Refer also to citation(s) 4967, 5261, 6130, 6184, 6468, 6569, 7041

6111 (DOE/CE/15529--T1) **Super heated vapor drying process.** Curry, D.P. (Merrill Air Technology, South Portland, ME (United States)). Thermodyne Evaporators, Portland, ME (United

States); Merrill Air Technology, South Portland, ME (United States). 22 Aug 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92CE15529. Order Number DE95003830. Source: OSTI; NTIS; GPO Dep.

The invention studied pertains to a super heated vapor drying process to be used in industrial drying.

6112 (DOE/CE/15554--T2) **Develop apparatus and process for second-stage drying. Quarterly progress report, September 26--December 26, 1994.** Taylor, F. Mississippi State Univ., MS (United States). Forest Products Lab. 5 Jan 1995. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-94CE15554. Order Number DE95005124. Source: OSTI; NTIS; GPO Dep.

Progress is reported on Task 1, Computer simulation refinement and extension, and its two subtasks: Verification of computer model simulation of the drying process for lumber in a superheated kiln and Establishment of energy loss predictions for specific kiln designs for the first stage kiln. A report of a trip to the Irvington Moore Corporation facility and plans for next quarter are described.

6113 (DOE/CE/23810--45) **Accelerated screening methods for predicting lubricant performance in refrigerant compressors: Final report.** Cusano, C.; Yoon, H.; Poppe, C. Illinois Univ., Urbana, IL (United States). Dept. of Mechanical and Industrial Engineering. Nov 1994. 141p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91CE23810. Order Number DE95003733. Source: OSTI; NTIS; GPO Dep.

The tribological characteristics of various lubricant/refrigerant mixtures have been experimentally investigated by means of a unique high pressure tribometer (HPT). In order to identify more effective bench testers for screening lubricants for compressors, a comparison is made between data obtained from the HPT, Four Ball and Falex™ testers, and those obtained from accelerated component (compressor) tests. Part 1 of this study is geared toward a comparison between data obtained from a Falex specimen tester and those obtained by the HPT. The main purpose of this comparison was to determine if the controlled environment and the lower loads used with the HPT produce different rankings than those obtained from the Falex tests. The results obtained from the HPT gave a consistent ranking a different loads and speeds and this ranking did not always correlate with that obtained from the Falex tester. In Part 2, the HPT is used to approximately simulate specific critical contacts in compressors to determine the degree to which it could predict lubricant performance. A comparison is made between data obtained from component tests and those obtained from the HPT. For comparison purposes, each lubricant is also tested and ranked based on results obtained in an air environment with both the HPT and a Four Ball machine. Based on wear data, the rankings of the lubricants obtained from the various testers are compared to the lubricant rankings obtained from the component tests. Assuming that the component data are correct, this comparison shows that approximately a 65% accuracy is obtained by means of the HPT operating in a pressurized refrigerant environment and that this accuracy is essentially the same as the accuracy with the HPT operating in an air environment, the Falex tester and the Four Ball tester.

6114 (DOE/EIA--0512(91)) **Manufacturing consumption of energy 1991.** USDOE Energy Information Administration, Washington, DC (United States). Office of Energy Markets and End Use. Dec 1994. 535p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004721. Source: OSTI; NTIS; GPO; GPO Dep.

This report provides estimates on energy consumption in the manufacturing sector of the US economy. These estimates are based on data from the 1991 Manufacturing Energy Consumption Survey (MECS). This survey--administered by the Energy End Use and Integrated Statistics Division, Office of Energy Markets and End Use, Energy Information Administration (EIA)--is the most comprehensive source of national-level data on energy-related information for the manufacturing industries.

6115 (ETDE/DE-mf--95726970) **Reduction of pollution through hydrogenation of carbon containing wastes. Second phase of project. Final report. Pt. 2. Figures and tables.** Rauser, G.; Jakubik, D. RWE - Gesellschaft fuer Forschung und Entwicklung mbH, Wesseling (Germany). Nov 1992. 97p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany);Ministerium fuer Wirtschaft, Mittelstand und Technologie des Landes Nordrhein-Westfalen, Duesseldorf (Germany). Foerderkennzeichen BMFT 01ZH8912. Order Number DE95726970. Source: OSTI; NTIS (US Sales Only).

Tests of many organic synthetic wastes during the first phase of the project showed, that these wastes can be transformed into valuable oils by hydrogenation (treatment with hydrogen at elevated temperatures and pressures). With increasing bottlenecks for other ways of disposal it was the target of the second phase of the project, to prove the possibility of technical realization of hydrogenating liquefaction of organic synthetic wastes. A bench scale plant was used for that examination, consisting of a thermal pretreatment (visbreaking and dechlorination) and a hydrogenation part with a capacity of 10 kg/h. In continuous test runs, lasting up to two weeks, it was proved, that mixtures of high-boiling oil and waste plastics (portion of plastics up to 60% and partly more, portion of PVC up to 6%) largely can be converted into liquid, chlorinefree hydrocarbons. An increase of the portion of plastics up to 100% seems to be technically realizable. The developed process is suitable to cycle plastics - especially from waste packing material - back as liquid material through ecologically beneficial hydrogenation. The step of thermal pretreatment needs additional optimizing. Part 2 of the final report contains figures and tables. (orig./BBR)

6116 (ETDE/DE-mf--95726971) **Reduction of pollution through hydrogenation of carbon containing wastes. Second phase of project. Final report. Pt. 1. Text.** Rauser, G.; Jakubik, D. RWE - Gesellschaft fuer Forschung und Entwicklung mbH, Wesseling (Germany). Nov 1992. 89p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany);Ministerium fuer Wirtschaft, Mittelstand und Technologie des Landes Nordrhein-Westfalen, Duesseldorf (Germany). Foerderkennzeichen BMFT 01ZH8912. Order Number DE95726971. Source: OSTI; NTIS (US Sales Only).

Tests of many organic synthetic wastes during the first phase of the project showed, that these wastes can be transformed into valuable oils by hydrogenation (treatment with hydrogen at elevated temperatures and pressures). With increasing bottlenecks for other ways of disposal it was the target of the second phase of the project, to prove the possiblity of technical realization of hydrogenating liquefaction of organic synthetic wastes. A bench scale plant was used for that examination, consisting of a thermal pretreatment (visbreaking and dechlorination) and a hydrogenation part with a capacity of 10 kg/h. In continuous test runs, lasting up to two weeks, it was proved, that mixtures of high-boiling oil and waste plastics (portion of plastics up to 60% and partly more, portion of PVC up to 6%) largely can be convertet into liquid, chlorinefree hydrocarbons. An increase of the portion of plastics up to 100% seems to be technically realizable. The developed process is suitable to cycle plastics - especially from waste packing material - back as liquid material through ecologically beneficial hydrogenation. The step of thermal pretreatment needs additional optimizing. (orig.)

6117 (ETDE/DE-mf--95733282) **Heating and air conditioning of motor cars with H_2O/zeolite sorption aggregates. Final report.** Hoeppler, R. (comp.). Bayerische Motoren Werke Antigua and Barbuda (BMW), Muenchen (Germany). Forschungs- und Ingenieurzentrum. Nov 1993. 76p. (In German). Order Number DE95733282. Source: OSTI; NTIS (US Sales Only).

The project was motivated by the current ozone depletion and greenhouse effect problem. The applicability of water/zeolite sorption system for air conditioning and heating of motor cars was investigated. (orig.)

6118 (IEE-SR--252) **Research on feasibility of utilization of spent vegetable oils as substitutes for petroleum derived oils.** Institute of Energy Economics, Tokyo (Japan). 16 May 1994. 174p. (In Japanese). Order Number DE95723044. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

Investigation and study were conducted on spent vegetable oil in terms of its potential resource amount and adaptability to fuel when

using it as petroleum substitution energy. Analysis of properties was made of spent soybean oil and rapeseed oil which form almost all the spent vegetable oil. As a result, it was found that spent vegetable oil is high in viscosity and distillation property and cannot be substituted for light oil in the way it is, but can meet standards for light oil if it is esterified. Moreover, spent vegetable oil cannot be used as fuel for gasoline-fueled automobiles, but can be used as a substitute of diesel powered automobile use light oil if esterified or mixed with light oil. For land internal combustion engine, it is usable if heated or mixed with light oil. For boiler use, spent vegetable oil can be used by itself, provided that heavy oil is used for firing and later spent vegetable oil takes the place of it. On the other hand, the resource amount of spent vegetable oil is below 1/100 of the demand for light oil, and substitutability of spent vegetable oil as resource is low. 83 refs., 63 figs., 72 tabs.

6119 (KCP–613-5469) **Pollution prevention and waste minimization in metal finishing.** Stimetz, C.J. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Dec 1994. 94p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. Order Number DE95004396. Source: OSTI; NTIS; GPO Dep.

This study was done to identify pollution prevention and waste minimization opportunities in the general plating department and the printed circuit board processing department. Recommendations for certain recycle and recovery technologies were mad in order to reduce usage of acids and the volume of heavy metal sludge that is formed at the industrial Wastewater Pretreatment Facility (IWPF). Some of these technologies discussed were acid purification, electrowinning, and ion exchange. Specific technologies are prescribed for specific processes. Those plating processes where the metals can be recovered are copper, nickel, gold, cadmium, tin, lead, and rhodium.

6120 (LA-UR–94-3313) **Elimination of solvents and waste by supercritical carbon dioxide in precision cleaning.** Williams, S.B.; Laintz, K.E.; Barton, J.C.; Spall, W.D. Los Alamos National Lab., NM (United States). [1994]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409178–6: American Chemical Society meeting on industrial and engineering chemistry, Atlanta, GA (United States), 19-21 Sep 1994). Order Number DE95001010. Source: OSTI; NTIS; GPO Dep.

Physiochemical properties of supercritical carbon dioxide make it ideally suited for removing commonly encountered contaminants found in the precision cleaning of optical components, computer parts, and electronic assemblies. Data will be presented on a survey demonstrating the successful removal of cutting and machine oils, silicon oils, body oils and hydraulic fluids from a variety of surfaces with supercritical carbon dioxide to, at, or below precision cleaning standards (less than 10 micrograms of contaminant per square centimeter of surface). Replicate studies were performed in both a small bench-scale unit (10 milliliter cleaning vessel) and in a large-scale unit (60 liter, 14 inch diameter cleaning vessel) showing the ability to scale small experiments to commercial sizes. Applicability of this supercritical fluid cleaning technique to commercial operations was evaluated in the areas of contaminant removal efficiencies, surface interactions, operational costs, and environmental waste reduction/elimination.

6121 (LBL–36510) **Diffusion behavior of lysozyme in aqueous ammonium sulfate solutions under varying solution conditions as determined by dynamic light scattering.** Fornefeld, U.M. (Univ. of California, Berkeley, CA (United States). Dept. of Chemical Engineering); Kuehner, D.E.; Blanch, H.W.; Prausnitz, J.M. Lawrence Berkeley Lab., CA (United States). Dec 1994. 24p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95004821. Source: OSTI; NTIS; GPO Dep.

As proteins gain significance in commercial applications such as pharmaceuticals, detergents, organic waste management and cosmetics, efficient and economical recovery of these valuable biomolecules is of increasing importance. the salting-out process has found widespread application in the area of protein separations. To date, salt-induced precipitation of proteins from complex aqueous solutions remains largely an empirical process; no comprehensive model exists to predict salting-out phase equilibria in protein solutions. Rational predictive models for salt-induced precipitation will therefore be of great value in protein purification, both on the preparative and the analytical scale. Any attempt to model theoretically salt-induced protein precipitation must include the known physics of protein interactions in aqueous solution. With this in mind, it is crucial to acknowledge that protein precipitation is fundamentally an aggregation process. In order to incorporate aggregation effects into ongoing efforts to model salting out of proteins, it is necessary to quantify the degree of aggregation as a function of solution conditions. Therefore, dynamic light scattering measurements were performed with a well-studied protein, hen-egg-white lysozyme, under several solution conditions.

6122 (NYSERDA–94-11) **Energy implications of integrated solid waste management systems. Final report.** Little, R.E.; McClain, G.; Becker, M.; Ligon, P.; Shapiro, K. New York State Energy Research and Development Authority, New York, NY (United States); Tellus Inst., Inc., Boston, MA (United States). Jul 1994. 424p. Sponsored by New York State Energy Research and Development Authority, Albany, NY (United States). Source: OSTI; New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223.

This study develops estimates of energy use and recovery from managing municipal solid waste (MSW) under various collection, processing, and disposal scenarios. We estimate use and recovery – or energy balance – resulting from MSW management activities such as waste collection, transport, processing, and disposal, as well as indirect use and recovery linked to secondary materials manufacturing using recycled materials. In our analysis, secondary materials manufacturing displaces virgin materials manufacturing for 13 representative products. Energy implications are expressed as coefficients that measure the net energy saving (or use) of displacing products made from virgin versus recycled materials. Using data developed for the 1992 New York City Master Plan as a starting point, we apply our method to an analysis of various collection systems and 30 types of facilities to illustrate bow energy balances shift as management systems are modified. In sum, all four scenarios show a positive energy balance indicating the energy and advantage of integrated systems versus reliance on one or few technology options. That is, energy produced or saved exceeds the energy used to operate the solid waste system. The largest energy use impacts are attributable to processing, including materials separation and composting. Collection and transportation energy are relatively minor contributors. The largest two contributors to net energy savings are waste combustion and energy saved by processing recycled versus virgin materials. An accompanying spatial analysis methodology allocates energy use and recovery to New York City, New York State outside the city, the U.S., and outside the U.S. Our analytical approach is embodied in a spreadsheet model that can be used by energy and solid waste analysts to estimate impacts of management scenarios at the state and substate level.

6123 (ORNL/TM–12864) **Experimental investigations of sensor-based surface following performed by a mobile manipulator.** Reister, D.B.; Unseren, M.A.; Baker, J.E.; Pin, F.G. Oak Ridge National Lab., TN (United States). Oct 1994. 58p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95004116. Source: OSTI; NTIS; GPO Dep.

We discuss a series of surface following experiments using a range finder mounted on the end of an arm that is mounted on a vehicle. The goal is to keep the range finder at a fixed distance from an unknown surface and to keep the orientation of the range finder perpendicular to the surface. During the experiments, the vehicle moves along a predefined trajectory while planning software determines the position and orientation of the arm. To keep the range finder perpendicular to the surface, the planning software calculates the surface normal for the unknown surface. We assume that the unknown surface is a cylinder (the surface depends on x and y but does not depend on z). To calculate the surface normal, the planning software must calculate the locations (x,y) of points on the surface in world coordinates. The calculation requires data

on the position and orientation of the vehicle, the position and orientation of the arm, and the distance from the range finder to the surface. We discuss four series of experiments. During the first series of experiments, the calculated surface normal values had large high frequency random variations. A filter was used to produce an average value for the surface normal and we limited the rate of change in the yaw angle target for the arm. We performed the experiment for a variety of concave and convex surfaces. While the experiments were qualitative successes, the measured distance to the surface was significantly different than the target. The distance errors were systematic, low frequency, and had magnitudes up to 25 mm. During the second series of experiments, we reduced the variations in the calculated surface normal values. While reviewing the data collected while following the surface of a barrel, we found that the radius of the calculated surface was significantly different than the measured radius of the barrel.

6124 (PNL–10044) **Supercritical carbon dioxide cleaning market assessment and commercialization/deployment plan.** Snowden-Swan, L.J. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94017394. Source: OSTI; NTIS; GPO Dep.

Through the US Department of Energy's Industrial Waste Program (IWP), work is being conducted to research, develop, and commercialize supercritical fluid cleaning for its potential as a safer technology in a wide range of industrial cleaning operations. Commercialization, which has not proceeded as quickly as expected, is being aided by the Joint Association for the Advancement of Supercritical Technology (JAAST), a research consortium made up of industry, university, and National Laboratory partners. Under the IWP, JAAST is facilitating interaction and communication among those involved in the technology and addressing specific issues slowing its growth and acceptance. As part of the IWP/JAAST effort, Pacific Northwest Laboratory conducted a study to (1) identify and evaluate potential markets for supercritical fluids cleaning, (2) identify and address current perceptions that inhibit the acceptance of the technology into industrial cleaning operations, and (3) develop a plan that will lead to successful deployment and implementation in potential market areas. The approach to gathering the information needed for formulating the plan was to interview several individuals involved in developing, using, or commercializing the technology, specifically, supercritical carbon dioxide ($SCCO_2$), the most commonly used fluid. Several potential markets were identified, including cleaning gyroscope and filling hardware; optical components; instrument bearings; computer disk drive components; medical devices; and fabrics, cloths, and rags. In cases where there are parts with intricate geometries, where water-based cleaning may corrode parts and materials, or where significant time and energy for drying is required, $SCCO_2$ may be an especially attractive alternative. While pursuing these applications, certain barriers still need to be overcome.

3206 Municipalities and Community Systems

Refer also to citation(s) 5276, 5535, 5968, 5983, 6103, 6115, 6116, 6122, 6310

6125 (CRIE-Y–93012) **Legal aspects of power failure. On limitation of liability for electric utilities.** Maruyama, M. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1994. 36p. (In Japanese). Order Number DE95730184. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

This paper studies methods of avoiding disputes and resolving problems, in order to clarify the limitation of liability for electric power utilities in the case of power failure. In Japanese electric power supply rules, the escape clause to limit reliability and compensation is not stipulated, beyond the principle of the Civil Law. Investigation was made on electric utility regulations in Japanese electric communication utilities and American and German electric utility regulations which stipulated the escape clause. The investigation reveals that there are various rules about the escape clause concerning the range of application (whether the clause is applicable to intentional or gross negligence, and whether it limits the amount of compensation not only per suffered customer but also over the case as a whole), and about the limit of compensation (whether the upper limit of the amount claimed). It is thought that, in public utilities, the compensation is included into the cost price in an appropriately calculated range, and in practice customers bear it as the power rate. Accordingly, the reason for determining the range of liability and compensation in the escape clause is to present beforehand customers in a package with the power rate standard corresponding to it as a contract. 35 refs., 2 figs., 6 tabs.

6126 (DOE/EA–0952) **The Louisiana State University waste-to-energy incinerator.** Department of Energy, Washington, DC (United States). Div. of Electric Energy Systems. 26 Oct 1994. 68p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004417. Source: OSTI; NTIS; INIS; GPO Dep.

This proposed action is for cost-shared construction of an incinerator/steam-generation facility at Louisiana State University under the State Energy Conservation Program (SECP). The SECP, created by the Energy Policy and Conservation Act, calls upon DOE to encourage energy conservation, renewable energy, and energy efficiency by providing Federal technical and financial assistance in developing and implementing comprehensive state energy conservation plans and projects. Currently, LSU runs a campus-wide recycling program in order to reduce the quantity of solid waste requiring disposal. This program has removed recyclable paper from the waste stream; however, a considerable quantity of other non-recyclable combustible wastes are produced on campus. Until recently, these wastes were disposed of in the Devil's Swamp landfill (also known as the East Baton Rouge Parish landfill). When this facility reached its capacity, a new landfill was opened a short distance away, and this new site is now used for disposal of the University's non-recyclable wastes. While this new landfill has enough capacity to last for at least 20 years (from 1994), the University has identified the need for a more efficient and effective manner of waste disposal than landfilling. The University also has non-renderable biological and potentially infectious waste materials from the School of Veterinary Medicine and the Student Health Center, primarily the former, whose wastes include animal carcasses and bedding materials. Renderable animal wastes from the School of Veterinary Medicine are sent to a rendering plant. Non-renderable, non-infectious animal wastes currently are disposed of in an existing on-campus incinerator near the School of Veterinary Medicine building.

6127 (DOE/IG–0359) **Audit of two of Bonneville Power Administration's residential conservation programs.** USDOE Office of Inspector General, Washington, DC (United States). Nov 1994. 20p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

This report addresses the audit of a residential conservation program. The Bonneville Power Administration (Bonneville) is required to reduce electricity usage in the region through cost-effective energy conservation. During the audit, two of Bonneville's residential conservation programs were reviewed: the Shower Head Program and the Washington State Builders Program. The objective of this audit was to determine if Bonneville effectively managed the cost of selected residential conservation programs. It was found that Bonneville was not effectively managing two residential conservation programs. Under the Shower Head Program, Bonneville paid for work that was not done and paid costs that exceeded established rates. Also, under the Washington State Builders Program, Bonneville paid more for energy conservation resources than it was responsible for under Washington State legislation. Between January 1992 and September 1993, Bonneville paid at least $2.3 million in excessive costs for the Shower Head Program and made $1.9 million in unnecessary payments for the Washington State Builders Program. Unless corrective actions are taken, it is estimated that Bonneville will pay future excessive costs of approximately $1 million for the Shower Head Program, and $4.8 million in unnecessary payments for the Washington State Builders Program. Therefore, it is recommended that Bonneville require a review of past shower head billings submitted by the electric utilities and establish a quality assurance process for future billings.

The authors also recommend that Bonneville make only the legislatively required amount of the builder payments, and discontinued all payments after June 30, 1995.

6128 (DTH-IMSOR-TR–1993-10) **On flow and supply temperature control in district heating systems.** Madsen, H.; Sejling, K.; Soegaard, H.T.; Palsson, O.P. Technical Univ. of Denmark, Lyngby (Denmark). Inst. of Mathematical and Operations Research. 1993. 20p. Contract ENS-1323/91-0010. Order Number DE95723831. Source: OSTI; NTIS.

EFP-91.

This paper discusses how the control of the flow and the supply temperature in district heating systems can be optimized, utilizing stochastic modeling, prediction and control methods. The main objective is to reduce heat production costs and heat losses in the transmission and distribution net by minimizing the supply temperature at the district heating plant. This control strategy is reasonable, in particular, if the heat production takes place at a combined heat and power (CHP) plant. The control strategy is subject to some restrictions, e.g., that the total heat requirement for all consumers is supplied at any time, and each individual consumer is guaranteed some minimum supply temperature at any time. Another important restriction is that the variation in time of the supply temperature is kept as small as possible. This concept has been incorporated in the program package PRESS developed at the Technical University of Denmark. PRESS has been applied and tested, e.g., at Vestkraft in Esbjerg, Denmark, and significant saving potentials have been documented. PRESS is now distributed by the Danish District Heating Association. (au) (19 refs.)

6129 (ETDE/DE-mf–95733291) **Two 30 kW wind power/diesel engine/battery systems - studies within the framework of the German-Chinese wind power project. Final report.** Baumgaertner, M. SMA System-, Mess- und Anlagentechnik - Regelsysteme GmbH, Niestetal (Germany). Apr 1993. 63p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0329035A. Order Number DE95733291. Source: OSTI; NTIS (US Sales Only).

The technical feasibility of wind power/diesel engine/battery systems for site conditions as found in Inner Mongolia was proved successfully within the framework of this BMFT project. The site conditions of Inner Mongolia are well-suited for the operation of wind power/diesel engine/battery systems. The plants, however, should be installed in villages whose power demand is high enough to ensure an economic utilization. (orig./HW)

6130 (IEE-SR–250) **Trend of on-site power generation in the manufacturing industry.** Institute of Energy Economics, Tokyo (Japan). Mar 1994. 229p. (In Japanese). Order Number DE95723045. Source: OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan.

The paper investigates and analyzes the present situation and the future trend of on-site power generation in the manufacturing industry. The on-site power generation had been rapidly increasing in the latter half of the 1980s, and in fiscal 1991 its generated output and equipment capacity reached 84.4 billion kWh and 17.8 million kW, respectively. Since around 1990, however, the on-site power generation has been slowing down. Its economic efficiency was evaluated by the pay-back period which obtained by dividing investment in on-site power generation facilities by annual merit which obtained by reducing annual expenses such as additional fuel cost from annual power rates reduced by introduction of the on-site power generation. As of 1991, the pay-back period was rather longer than in the latter half of the 1980s. This is because the heavy oil price was substantially lower as compared with power rates in the latter half of the 1980s, but the heavy oil price increased and power rates were on the low level in and after around 1990. Even if power rates maintain the present level and fuel cost decreased to the cost in the latter half of the 1980s, the pay-back period will be only a little bit longer. Hereafter, the higher the fuel cost becomes, the less on-site power generation will be introduced except for large-scale cogeneration. 4 refs., 70 figs., 32 tabs.

6131 (LBL–35680) **Review of performance-based ratemaking plans for US gas distribution companies.** Comnes, G.A. (Lawrence Berkeley Lab., CA (United States). Energy and Environment Div.). Lawrence Berkeley Lab., CA (United States). Nov 1994. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95004814. Source: OSTI; NTIS; GPO Dep.

Performance-Based Ratemaking (PBR) is receiving increasing attention by energy utilities and their regulators. PBR is the industry term for forms of regulation that increase financial incentive for performance relative to traditional cost-of-service/rate-of-return (COS/ROR) regulation. In this report, PBR plans filed by US gas local distribution companies (LDCs) are described and reviewed. The rationale behind energy utility PBR is presented and discussed. Using nine plans that have been proposed by eight LDCs as a basis, a framework (typology) to facilitate understanding of gas utility PBR is presented. Plans are categorized according to the range of services covered by the PBR mechanism and the scope of the mechanism's cost coverage within a service category. Pivotal design issues are identified and, based on the sample of plans, observations are made. Design issues covered include the length of time that the PBR is in effect (term); the relationship between PBR plans and status quo ratemaking; methods for formulating cost or rate indices, earnings sharing mechanisms, and service quality indices; and compatibility with gas utility DSM programs. The report summarizes observations that may be considered supportive of the rationale behind PBR. PBR is, however, not clearly superior to traditional regulation and few PBRs that are broad in scope have been adopted long enough to allow for a empirical analysis. Thus, the report concludes by identifying and describing commonly-cited pitfalls of PBR.

6132 (NREL/TP–430-7382) **Utilization of ash from municipal solid waste combustion. Final report, Phase I.** Jones, C.M.; Hartman, R.M.; Kort, D.; Rapues, N. National Renewable Energy Lab., Golden, CO (United States). Sep 1994. 191p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000212. Source: OSTI; NTIS; GPO Dep.

This ash study investigates several aspects of Municipal Waste Combustion (MWC) ash utilization to develop an alternative to the present disposal practice of landfilling in a lined monofill. Ash was investigated as a daily or final cover for municipal waste in the landfill to prevent erosion and as a road construction aggregate. Samples of eight mixtures of ash and other materials, and one sample of soil were analyzed for chemical constituents. Biological tests on these mixters were conducted, along with erosion tests and sieve analyses. A chemical analysis of each sieve size was conducted. Geotechnical properties of the most promising materials were made. Findings to this point include: all ash samples take have passed the EPA TCLP testing; chemical analysis of bottom and combined ash samples indicate less than expected variability; selected ash mixtures exhibited very low coefficients of hydraulic conductivity; all but one of the ash mixtures exhibited greater erosion resistance than the currently used landfill cover material; MWC combined analysis indicates this is a viable alternative for landfill cover; MWC ash size reactions and chemical analysis show bottom and combined ash to be a viable alternative for road construction.

6133 (NUTEK-FJV–94-6) **CFC-free polyurethane foam.** Jarfelt, U. (Division of Building Technology, Chalmers University of Technology, Gothenburg (Sweden)). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. 204p. (In Swedish, English). Project NUTEK-656-101. Order Number DE95723995. Source: OSTI; NTIS.

This is the final report of a project aimed at creating and maintaining a group of scientists with interdisciplinary character and competence, to build up a knowledge about the material polyurethane, and to study the possibilities available after the ban on chlorofluorocarbons. The report comprise a summary in Swedish and 7 specialist papers in English, of which 6 are separately indexed.

6134 (ORNL/CON–402) **Price impacts of electric-utility DSM programs.** Hirst, E.; Hadley, S. Oak Ridge National Lab., TN

(United States). Nov 1994. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95004406. Source: OSTI; NTIS; GPO Dep.

As competition in the electricity industry increases, utilities (and others) worry more about the upward pressure on electricity prices that demand-side management (DSM) programs often impose. Because of these concerns, several utilities have recently reduced the scope of their DSM programs or focused these programs more on customer service and peak-demand reductions and less on improving energy efficiency. This study uses the Oak Ridge Financial Model (ORFIN) to calculate the rate impacts of DSM. The authors use ORFIN to examine the two factors that contribute to DSM's upward pressure on prices: the cost of the programs themselves and the loss of revenue associated with fixed-cost recovery. This second factor reflects the reduction in revenues caused by the DSM-induced energy and demand savings that exceed the reduction in utility costs. This analysis examines DSM price impacts as functions of the following factors: the DSM program itself (cost, conservation load factor, geographic focus on deferral of transmission and distribution investments, and mix across customer classes); the utility's cost and pricing structures (factors at least partly under the utility's control, such as retail tariffs, fixed vs variable operating costs, and capital costs not related to kW or kWh growth); and external economic and regulatory factors (the level and temporal pattern of avoided energy and capacity costs; rate-basing vs expensing of DSM-program costs; shareholder incentives for DSM programs; load growth; and the rates for income, property, and revenue taxes).

6135 (ORNL/CON–403) **Summary of California DSM impact evaluation studies.** Brown, M.A. (Oak Ridge National Lab., TN (United States)); Mihlmester, P.E. Oak Ridge National Lab., TN (United States). Oct 1994. 84p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95004164. Source: OSTI; NTIS; GPO Dep.

Over the past several years, four of the largest investor-owned California utilities have completed more than 50 evaluation studies designed to measure the energy and demand impacts of their demand-side management (DSM) programs. These four are: Pacific Gas and Electric (PG and E), Southern California Edison (SCE), Southern California Gas (SoCalGas), and San diego Gas and Electric (SDG and E). These studies covered residential, commercial, industrial, and agricultural DSM programs and provided a wealth of information on program impacts. The objective of this report is to summarize the results of these DSM evaluation studies in order to describe what DSM has achieved in California, to assess how well these achievements were forecast, and to compare the effectiveness of different types of DSM programs. This report documents the sizable investment made by the California utilities in their 1990–92 DSM programs. Between 1990 and 1992, the four utilities spent $772 million on energy-efficiency/conservation programs. This report also summarizes the realization rates estimated by the 50+ evaluation studies. Realization rates are defined as ex-post net savings estimates divided by ex-ante net savings estimates. Realization rates are summarized for 158 programs and program segments.

6136 (PNL-SA–24187) **Cost-effective energy efficiency in the Czech Republic.** Shankle, S.A. (Pacific Northwest Lab., Richland, WA (United States)); Secrest, T.J.; Zemen, Z.; Popelka, A. Pacific Northwest Lab., Richland, WA (United States). Aug 1994. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-940893–17: Summer conference on energy efficiency in buildings, Monterey, CA (United States), 29 Aug - 3 sep 1994). Order Number DE95003135. Source: OSTI; NTIS; GPO Dep.

Energy efficiency is a particularly important issue in the emerging economies of Eastern Europe. Much of the energy used in the Czech Republic is supplied by lignite, a soft brown form of coal. Its combustion is largely responsible for an extreme acid rain problem and other forms of air pollution and land use complications. Additionally, inefficient energy use is prevalent, placing additional stresses on an already fragile economy. This paper reports on a project in the mid-sized (250,000 residents) and industrial city of Plzen, in the Czech Republic. The Facility Energy Decision Screening (FEDS) process, developed by PNL for the U.S. Department of Energy's (DOE's) Federal Energy Management Program (FEMP), was applied to the city to determine the level of cost-effective energy efficiency potential in the city. Significant potential was found to exist, primarily in large, cooperatively owned apartment buildings heated by district systems.

33 ADVANCED PROPULSION SYSTEMS

3301 Internal Combustion Engines

Refer also to citation(s) 6159, 6238, 6336

6137 (DOE/CE/90049–T1) **Investigation of a rotary valving system with variable valve timing for internal combustion engines: Final technical report.** Cross, P.C.; Hansen, C.N. Hansen Engine Corp., Minnetonka, MN (United States). 18 Nov 1994. 92p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-89CE90049. Order Number DE95003831. Source: OSTI; NTIS; GPO Dep.

The objective of the program was to provide a functional demonstration of the Hansen Rotary Valving System with Variable Valve timing (HRVS/VVT), capable of throttleless inlet charge control, as an alternative to conventional poppet-valves for use in spark ignited internal combustion engines. The goal of this new technology is to secure benefits in fuel economy, broadened torque band, vibration reduction, and overhaul accessibility. Additionally, use of the variable valve timing capability to vary the effective compression ratio is expected to improve multi-fuel tolerance and efficiency. Efforts directed at the design of HRVS components proved to be far more extensive than had been anticipated, ultimately requiring that proof-trial design/development work be performed. Although both time and funds were exhausted before optical or ion-probe types of in-cylinder investigation could be undertaken, a great deal of laboratory data was acquired during the course of the design/development work. This laboratory data is the basis for the information presented in this Final Report.

6138 (DOE/CH/10093–245, pp. 175-186) **Development of a spark ignited DI methanol engine for passenger car application.** Bartunek, B. (FEV Motorentechnik GmbH & Co. KG, Aachen (Germany)); Schmidt, R.; Last, R.J.; Rogers, G.W.; Heinrich, H.; Weidmann, K. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Methanol is regarded as a primary potential source of fuel for the transportation sector. A significant fraction of the effort which has been directed toward development of spark ignited methanol engines has been invested in conventional port injected, homogeneous, premixed charge. Otto cycle engines. These engines have been characterized by cold start difficulties and high cold start emissions. Within a research program sponsored by the U.S. Environmental Protection Agency in co-operation with Volkswagen AG, a direct injected, spark ignited methanol engine has been developed. The baseline engine for this development was a high swirl, stratified charge, DI prototype gasoline engine for passenger car application. The engine features an EGR system as well as an oxidation catalyst. The methanol engine exhibits very low NOx emissions and a favorable fuel consumption behavior associated with higher compression ratio, DI concepts. The use of an oxidation catalyst. The methanol engine exhibits very low NOx emissions and a favorable fuel consumption behavior associated with higher compression ratio, DI concepts. The use of an oxidation catalyst allows comparably low levels for the tailpipe emissions. The results of the engine/vehicle development program is presented and discussed. The influence of specific engine operational parameters on fuel consumption and emissions is demonstrated and a comparative assessment of this technology with other DI methanol concepts for passenger car engines is provided with regard to the U.S. FTP-75 test results.

6139 (DOE/CH/10093–245, pp. 321-341) **Demonstration tests for converting oil fuel to methanol in thermal power plants: Methanol engine system for power generation.** Yamada, I. (New Energy and Industrial Technology Development Organization (Japan)); Inenaga, N.; Morimoto, H. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Methanol is now considered a clean oil-alternative energy source for electric power plants. NEDO has been conducting R&D on power generation from methanol in "Demonstration Tests for converting Oil Fuel to Methanol in Thermal Power Plants: since FY1981 by commission of the Agency of Natural Resources and Energy, Ministry of International Trade and Industry. In FY1988 NEDO began conducting "Demonstration Tests on a Reformed Methanol Gas Turbine Generation System: with one of the main objectives being recovering waste heat by taking advantage of the reforming reaction of methanol. Since FY1989, NEDO has also been conducting "Developmental Research on Methanol Engine System for Power Generation", aiming at the low discharge of NO_x by methanol conversion of an oil-burning stationary diesel engine power generation system and a co-generation system. This paper reports the experimental results obtained in "Developmental Research on Methanol Engine System for Power Generation".

6140 (DOE/ER/12115–T1) **The railplug: Development of a new ignitor for internal combustion engines. Final report.** Matthews, R.D.; Nichols, S.P.; Weldon, W.F. Texas Univ., Austin, TX (United States). 29 Nov 1994. 70p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER12115. Order Number DE95004375. Source: OSTI; NTIS; GPO Dep.

A three year investigation of a new type of ignitor for internal combustion engines has been performed using funds from the Advanced Energy Projects Program of The Basic Energy Sciences Division of the U.S. Department of Energy and with matching funding from Research Applications, Inc. This project was a spin-off of "Star Wars" defense technology, specifically the railgun. The "railplug" is a miniaturized railgun which produces a high velocity plume of plasma that is injected into the combustion chamber of an engine. Unlike other types of alternative ignitors, such as plasma jet ignitors, electromagnetic forces enhance the acceleration of the plasma generated by a railplug. Thus, for a railplug, the combined effects of electromagnetic and thermodynamic forces drive the plasma into the combustion chamber. Several engine operating conditions or configurations can be identified that traditionally present ignition problems, and might benefit from enhanced ignition systems. One of these is ultra-lean combustion in spark ignition (SI) engines. This concept has the potential for lowering emissions of NOx while simultaneously improving thermal efficiency. Unfortunately, current lean burn engines cannot be operated sufficiently lean before ignition related problems are encountered to offer any benefits. High EGR engines have similar potential for emissions improvement, but also experience similar ignition problems, particularly at idle. Other potential applications include diesel cold start, alcohol and dual fuel engines, and high altitude relight of gas turbines. The railplug may find application for any of the above. This project focused on three of these potential applications: lean burn SI engines, high EGR SI engines, and diesel cold start.

6141 (EGG–11265-3011) **Turbine-engine applications of thermographic-phosphor temperature measurements.** Noel, B.W. (Noel Associates, Espanola, NM (United States)); Turley, W.D.; Allison, S.W. EG and G Energy Measurements, Inc., Goleta, CA (United States). [1995]. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-9410259–1: Remote temperature sensing workshop, Cleveland, OH (United States), 27-28 Oct 1994). Order Number DE95003625. Source: OSTI; NTIS; GPO Dep.

Includes vugraphs.

The thermographic-phosphor (TP) method can measure temperature, heat flux, strain, and other physical quantities remotely in hostile and/or inaccessible environments such as the first-stage turbine components in turbine engines. It is especially useful in situations in which no other known method works well. This paper is a brief review of engine tests that demonstrated the utility of the TP method. For the most part, the results presented here are discussed only qualitatively. The papers in the bibliography describe these and other experiments and results in detail. The first viewgraph summarizes the many desirable features of the TP method. The second viewgraph describes TPs, and the third summarizes how the TP method works. To measure single-point temperatures in turbine-engine applications, we use the decay-time method, which depends on the fact that the luminescence following an impulse of ultraviolet excitation decays, with a characteristic decay time that. Is a monotonically decreasing function of temperature over some range of temperatures. The viewgraph is a set of calibration curves showing the behavior of some useful emission lines for ten important TPs. Consider Lu PO_4:Eu as an example. Below the "quenching" temperature near 900 Y, the decay time is nearly constant. Above it, the decay time decreases exponentially with the temperature. This strong functional dependence means that one can have a fairly large error in the lifetime measurement, as in environments with poor signal-to-noise ratios (SNRs), yet still obtain high accuracy in the temperature measurement. Our more-recent data up to 1900 K show the same behavior.

6142 (NREL/TP–425-6354) **Diesel fuel component contribution to engine emissions and performance. Final report.** Erwin, J. (Southwest Research Institute, San Antonio, TX (United States)); Ryan, T.W. III; Moulton, D.S. National Renewable Energy Lab., Golden, CO (United States); Southwest Research Inst., San Antonio, TX (United States). Nov 1994. 143p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. Order Number DE95000238. Source: OSTI; NTIS; GPO Dep.

Contemporary diesel fuel is a blend of several refinery streams chosen to meet specifications. The need to increase yield of transportation fuel from crude oil has resulted in converting increased proportions of residual oil to lighter products. This conversion is accomplished by thermal, catalytic, and hydrocracking of high molecular weight materials rich in aromatic compounds. The current efforts to reformulate California diesel fuel for reduced emissions from existing engines is an example of another driving force affecting refining practice: regulations designed to reduce exhaust emissions. Although derived from petroleum crude oil, reformulated diesel fuel is an alternative to current specification-grade diesel fuel, and this alternative presents opportunities and questions to be resolved by fuel and engine research. Various concerned parties have argued that regulations for fuel reformulation have not been based on an adequate data base. Despite numerous studies, much ambiguity remains about the relationship of exhaust parameters to fuel composition, particularly for diesel fuel. In an effort to gather pertinent data, the automobile industry and the oil refiners have joined forces in the Air Quality Improvement Research Program (AUTO/OIL) to address this question for gasoline. The objective of that work is to define the relationship between gasoline composition and the magnitude and composition of the exhaust emissions. The results of the AUTO/OEL program will also be used, along with other data bases, to define the EPA "complex model" for reformulated gasolines. Valuable insights have been gained for compression ignition engines in the Coordinating Research Council's VE-1 program, but no program similar to AUTO/OIL has been started for diesel fuel reformulation. A more detailed understanding of the fuel/performance relationship is a readily apparent need.

6143 (UCRL-JC–116894) **Optimized hydrogen piston engines.** Smith, J.R. Lawrence Livermore National Lab., CA (United States). 10 May 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9410256–1: Society of Automotive Engineers' convergence '94, Detroit, MI (United States), 18 Oct 1994). Order Number DE95003656. Source: OSTI; NTIS; GPO Dep.

Hydrogen piston engines can be simultaneously optimized for improved thermal efficiency and for extremely low emissions. Using these engines in constant-speed, constant-load systems such as series hybrid-electric automobiles or home cogeneration systems can result in significantly improved energy efficiency. For the same

electrical energy produced, the emissions from such engines can be comparable to those from natural gas-fired steam power plants. These hydrogen-fueled high-efficiency, low-emission (HELE) engines are a mechanical equivalent of hydrogen fuel cells. HELE engines could facilitate the transition to a hydrogen fuel cell economy using near-term technology.

3303 Electric-Powered Systems

Refer also to citation(s) 6078, 6083, 6147

6144 (ANL/ES/CP–84138) **Energy efficiency of electric vehicles at the 1994 American Tour de Sol.** Quong, S.; Duoba, M.; Buitrago, C.; LeBlanc, N.; Larsen, R. Argonne National Lab., IL (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9410241–1: Solar and electric vehicles '94, Providence, RI (United States), 3-5 Oct 1994). Order Number DE95002905. Source: OSTI; NTIS; GPO Dep.

In 1994, the US Department of Energy, through Argonne National Laboratory's Center for Transportation Research, sponsored energy-efficiency data collection from student, private, and professional electric vehicles during the American Tour de Sol (ATdS). The ATDS is a multiple-day road rally event, from New York City to Philadelphia. During each leg of the event, kilowatt-hour meters measured the efficiency of the electric vehicles (EVs), which averaged from 5.68 to 65.74 km/kWh. In addition to daily energy-usage measurements, some vehicles used a data-acquisition unit to collect second-by-second information. This showed, in one case, that 21% of the total energy was captured in regenerative braking. Some of the vehicles were also tested on a dynamometer for energy-efficiency, acceleration, and steady-state power ratings. This paper also compares the energy efficiency of the vehicles during the road rally to the dynamometer results. In almost all vehicles, there was an increase in energy efficiency when the vehicle was traveling over the road, due to the non-transient duty cycle and efficient driving techniques. The dynamometer testing also showed that some EVs are equal to or better than gasoline vehicles in performance and efficiency.

6145 (UCRL-JC–116834) **Load calculation and system evaluation for electric vehicle climate control.** Aceves, S.M.; Comfort, W.J. III. Lawrence Livermore National Lab., CA (United States). 12 Sep 1994. 25p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950256–2: Society of Automotive Engineers international congress and exposition, Detroit, MI (United States), 27 Feb - 2 mar 1995). Order Number DE95004350. Source: OSTI; NTIS; GPO Dep.

This paper presents an analysis of the applicability of alternative systems for electric vehicle (EV) heating and air conditioning (HVAC). The paper consists of two parts. The first part is a cooling and heating load calculation for electric vehicles. The second part is an evaluation of several systems that can provide the desired cooling and heating in EVs. These systems are ranked according to their overall weight The overall weight is calculated by adding the system weight and the weight of the battery necessary to provide energy for system operation. The system with the minimum overall weight is considered to be the best, because minimum vehicle weight decreases the energy required for propulsion, and therefore increases the vehicle range. Three systems are considered as the best choices for EV HVAC. These are, vapor compression, ice storage and adsorption systems. These systems are evaluated, including calculations of system weight, system volume, and COP. The paper also includes a calculation on how the battery energy storage capacity affects the overall system weights and the selection of the optimum system. The results indicate that, at the conditions analyzed in this paper, an ice storage system has the minimum weight of all the systems considered. Vapor compression air conditioners become the system with the minimum weight for battery storage capacities above 230 kJ/kg.

6146 (WHC-SD-RTG-SDP–001) **Radioisotope thermoelectric generator transportation system subsystem 143 software development plan.** King, D.A. Westinghouse Hanford Co., Richland, WA (United States). 10 Nov 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003774. Source: OSTI; NTIS; INIS; GPO Dep.

This plan describes the activities to be performed and the controls to be applied to the process of specifying, developing, and qualifying the data acquisition software for the Radioisotope Thermoelectric Generator (RTG) Transportation System Subsystem 143 Instrumentation and Data Acquisition System (IDAS). This plan will serve as a software quality assurance plan, a verification and validation (V and V) plan, and a configuration management plan.

3304 Hybrid Systems

Refer also to citation(s) 6129

6147 (UCRL-JC–117918) **A hybrid vehicle evaluation code and its application to vehicle design.** Aceves, S.M.; Smith, J.R. Lawrence Livermore National Lab., CA (United States). 15 Jul 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950256–1: Society of Automotive Engineers international congress and exposition, Detroit, MI (United States), 27 Feb - 2 mar 1995). Order Number DE95004205. Source: OSTI; NTIS; GPO Dep.

This report describes a hybrid vehicle simulation model, which can be applied to many of the vehicles currently being considered for low pollution and high fuel economy. The code operates interactively, with all the vehicle information stored in data files. The code calculates fuel economy for three driving schedules, time for 0-96 km/h at maximum acceleration, hill climbing performance, power train dimensions, and pollution generation rates. This report also documents the application of the code to a hybrid vehicle that operates with a hydrogen internal combustion engine. The simulation model is used for parametric studies of the vehicle. The results show the fuel economy of the vehicle as a function of vehicle mass, aerodynamic drag, engine-generator efficiency, flywheel efficiency, and flywheel energy and power capacities.

3307 Emission Control

Refer also to citation(s) 4947, 6142, 6284, 6621

6148 (ETDE/DE-mf–95733314) **Catalytic regeneration of diesel soot filters. Final report.** Loewe, A. Technische Univ. Braunschweig (Germany). Inst. fuer Technische Chemie. 16 Sep 1991. 29p. (In German). Sponsored by Niedersaechsisches Ministerium fuer Wissenschaft und Kultur, Hannover (Germany). Contract 0608TG74. Order Number DE95733314. Source: OSTI; NTIS (US Sales Only).

A regeneration process was investigated. For this purpose, fuel was injected into the exhaust live upstream of the soot filter. The feasibility of the process was proved in a small experimental facility at exhaust temperatures of only 300 C and at an oxygen concentration of 7%. In the present investigation, butane instead of diesel fuel was added to the exhaust gas. It was added only initially, i.e. until regeneration could take place. As soon as the temperature at the filter front side was sufficient, the butane supply was stopped, and regeneration took place. (orig./EF)

3308 Alternative Fuels

Refer also to citation(s) 5524, 5525, 5526, 5534, 6138, 6139, 6621

6149 (CONF-940301–41) **Fuel composition effects on natural gas vehicle emissions.** Blazek, C.F. (Institute of Gas Technology, Chicago, IL (United States)); Grimes, J.; Freeman, P.; Bailey, B.K.; Colucci, C. Institute of Gas Technology, Chicago, IL (United States). [1994]. 8p. Sponsored by Institute of Gas Technology, Chicago, IL (United States). From 207. spring national meeting of the American Chemical Society (ACS); San Diego, CA (United States); 13-18 Mar 1994. Source: OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616.

Under a contract from DOE's National Renewable Energy Laboratory (NREL) and support from Brooklyn Union Gas Company (BUG), Northern Illinois Gas Co., the Institute of Gas Technology (IGT) evaluated four state-of-the-art, electronic, closed-loop natural

gas vehicle (NGV) conversion systems. The systems included an Impco electronic closed-loop system, Mogas electronic closed-loop system, Stewart and Stevenson's GFI system, and an Automotive Natural Gas Inc. (ANGI) Level 1 electronic closed-loop conversion system. Conversion system evaluation included emission testing per 40 CFR Part 86, and driveability. All testing was performed with a 1993 Chevy Lumina equipped with a 3.1 liter MPFI V6 engine. Each system was emission tested using three different certified compositions of natural gas, representing the 10th, mean and 90th percentile gas compositions distributed in the United States. Emission testing on indolene was performed prior to conversion kit testing to establish a base emission value. Indolene testing was also performed at the end of the project when the vehicle was converted to its OEM configuration to ensure that the vehicle's emissions were not altered during testing. The results of these tests will be presented.

6150 (DOE/CH/10093–245, pp. 3-24) **Methanol vehicle emissions round robin test program.** Hoekman, S.E.; Jensen, T.E. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

A vehicle emissions round robin test program was conducted using a methanol-fueled vehicle operating on M85. Each of 16 participants conducted two to six Federal Test Procedure (FTP) emissions tests. All participants measured emission rates of hydrocarbon (HC), CO, NO_x, methanol, formaldehyde, and acetaldehyde. One participant, designated as a reference lab, conducted emissions testing at the beginning, the end, and two intermediate times during the round robin. Results of the reference lab demonstrated that no significant drift in emissions levels occurred during the 2-year program. Relative lab-to-lab variability for FTP-composite emissions was lowest for NO_x, with a coefficient of variation (C.V.) of 12%. CO variability was 16%, HC variabilities (by GC and bench FID) were 17 and 35% respectively. Methanol, formaldehyde, and acetaldehyde were found to have variabilities of 34, 17, and 63%, respectively. The large difference between formaldehyde and acetaldehyde variability is probably a consequence of their different concentrations–formaldehyde's emission rate was approximately 40 times that of acetaldehyde. This consistent with an expected increase in variability at emission levels near detection limits. Emission rates of three HC species were also determined: methane, benzene, and toluene. They showed variabilities ranging from 20-30%, only slightly higher than for the criteria emissions.

6151 (DOE/CH/10093–245, pp. 25-41) **Technology assessment of light-duty methanol vehicles.** Browning, L.H.; McCormack, M.C. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Light duty methanol vehicle development activities over the last decade have culminated in the certification of three different vehicle models of production fuel flexible vehicles (FFVs) to California Low Emission Vehicle standards for the 1993 model year, one year ahead of the 1994 regulation requirement established by the California Air Resources Board. Steady progress in the improvement of emissions and fuel economy while maintaining good drivability and performance has characterized the development process for this technology. Emissions and fuel economy results indicate that FFVs operating on methanol (M85) can achieve advanced emission standards and reduce air toxic emissions relative to conventional and reformulated gasolines. Toxic air pollutant data from FFVs operating on M85 fuel which achieve Non-Methane Organic Gas (NMOG) emission levels close to the Transitional Low-Emission Vehicle (TLEV) standard indicate reductions in toxic (cancer weighted) risk of 50 to 80 percent for M85 fuel relative to risks associated with gasoline in FFVs and low-emission gasoline vehicles. The data support the conclusion that FFV technology is capable of achieving stringent California emissions standards while reducing air toxic emissions and improving energy based fuel economy relative to existing and reformulated gasolines.

6152 (DOE/CH/10093–245, pp. 42-48) **Canadian Methanol Light Duty Vehicle program.** Spacek, J. (Canadian Oxygenated Fuels Association, Ottawa, Ontario (Canada)); Colledge, R. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The Canadian Oxygenated Fuels Association, with assistance from: the federal government, three provincial governments, automobile manufacturers, fuel marketers, fuel dispensing equipment industry, and others, have initiated a National Methanol Light Duty Vehicle Demonstration Program. This program started in 1991 with the following objectives: to supply flexible fuelled methanol vehicles to fleet users to operate in the Canadian climate; to provide a methanol fuel infrastructure in those areas where the vehicles will be located; and to address technical/developmental issues in the implementation of methanol fuel in Canada. This paper reviews the main results to data.

6153 (DOE/CH/10093–245, pp. 51-62) **General motors specifications for fuel methanol and ethanol.** Brinkman, N.D. (General Motors NAO Research and Development Center, Warren, MI (United States)); Halsall, R.; Jorgensen, S.W.; Kirwan, J.E. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Fuel Alcohols, such as M85 (blend of 85 percent by volume methanol with hydrocarbons) and E_d85 (blend of 85 percent by volume denatured ethanol with hydrocarbons), are inherently involatile at low temperatures and may contain soluble or insoluble contaminants. Existing fuel specifications do not adequately address these properties, which may adversely affect vehicle performance and durability. To improve customer satisfaction with alcohol-fueled vehicles, we developed new fuel specifications for M85 and E_d85. This paper presents and discusses these specifications, which are based on studies of fuel effects on cold starting, vapor flammability, and durability.

6154 (DOE/CH/10093–245, pp. 65-73) **Methanol fuel formulation issues.** Wiens, J. (California Energy Commission Transportation Technology and Fuels Office, Sacramento, CA (United States)); Cox, E.; Fanick, E.R.; Smith, L.R. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

There are a number of issues regarding the formulation or quality of methanol fuels that have become apparent in the demonstration of light- and heavy-duty methanol vehicles in California. This paper will outline and provide some discussion of the following issues: (1) Additives to M100 for flame luminosity improvement. (2) The potential impacts of gasoline deposit control additives and methanol fuel distribution system corrosion products on the reliability and component durability of methanol fuel flexible vehicles. (3) Additives to methanol for fuel injector and fuel pump durability improvement in diesel cycle engines. (4) The impacts on fuel injector durability and NO_x emissions of the use of M85 in two-stroke, heavy-duty methanol engines designed for M100. (5) M100 ignition improve additive prices vs. heavy-duty methanol engine design cost savings. (6) Fuel grade methanol: what is it, what are the potential cost savings in production and transport, and will it make methanol competitive with gasoline and diesel?

6155 (DOE/CH/10093–245, pp. 105-109) **DOE fleet test activities with alcohol fuel buses.** Wares, R. (Department of Energy, Washington, DC (United States)); Krenelka, T. National

Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The current status of the DOE Alternative Fuel Bus Data Collection Program is discussed in this paper. This program supports the activities of the U.S. Department of Energy (DOE) in fulfilling the requirements of the Urban Bus Program of the Alternative Motor Fuels Act (AMFA) of 1988. The program is a focused study of the alternative fuel buses in service at five selected transit agencies. Results from the alcohol-fuel bus activities are presented.

6156 (DOE/CH/10093–245, pp. 113-120) **Reactivity adjustment factor for vehicles operating on E85.** Marshall, W.F. (National Institute for Petroleum and Energy Research, Bartlesville, OK (United States)). National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The objective of this project is to obtain emissions data appropriate for use to establish a generic reactivity adjustment factor for ethanol. This will enable the inclusion of ethanol in the California Air Resources Board Schedule of alternative fuel options for vehicles in the Transitional Low-Emission Vehicle category of low-emission vehicles. Four 1992 Chevrolet Lumina variable fuel vehicles that were calibrated for ethanol were used in this work. A single batch of E85 was used for mileage accumulation and emissions testing. The emissions tests for generating reactivity data were conducted after the vehicles had accumulated 4,000 miles. The Federal Test Procedure was used for the emission test, which were done in triplicate for all four vehicles. Vehicle conditioning followed the Auto/Oil procedures. The exhaust speciations included aldehydes and ketones (by high performance liquid chromatography) and alcohols and hydrocarbons (by gas chromatography). The average reactivity adjustment factor for the 12 tests was 0.68; that is, the reactivity per gram of non-methane organic gases was 68% of that of conventional gasoline. The range of reactivity adjustment factor determinations was 0.61 to 0.79 with a coefficient of variation of 7% for the 12 tests. The appropriate emission standards were met in all 12 tests. Emission levels of toxics were low for all except acetaldehyde, which is formed by the partial oxidation of ethanol. The average emission rate for total toxics was 26 milligrams per mile. Acetaldehyde constituted nearly 80% of this total.

6157 (DOE/CH/10093–245, pp. 123-133) **The ethanol heavy duty truck fleet demonstration program.** Marek, N.J. (Illinois Department of Energy and Natural Resources, Springfield (United States)); Stamper, K.R.; Miller, S. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The purpose of this project is to determine the performance, reliability, cost of operation and emissions from over-the-road trucks operating on high percentages of ethanol fuel and represents the first information collected on these types of vehicles. The first fleet of four ethanol trucks, owned and operated by ADM, are 1992 White-GMC WIM64T models powered by Detroit Diesel Corporation (DDC) 300 horsepower, dedicated ethanol 6V-92TA engines with 9-speed manual transmission. Initially, the trucks are being operated on short routings, allowing them to return to the terminal each night. Eventually, interstate routings will be included as part of the operating routine. The emissions testing data for this program has been performed by the U.S. DOE/University of West Virginia Transportable Emissions Testing Center and from transient emissions tests by Detroit Diesel Corporation.

6158 (DOE/CH/10093–245, pp. 134-141) **Demonstration program for heavy-duty vehicles equipped with ethanol powered diesel engines.** Berg, R. (Befri Konsult, Huddinge (Sweden)). National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The Swedish government and other entities such as the Swedish Ethanol Foundation and SAAB SCANIA are engaged in a number of projects to determine the technical feasibility and economic viability of meeting a portion of Sweden's transportation fuel needs with ethanol. All aspects of substituting ethanol for conventional petroleum derived fuels are being studied. Laws and regulations which may restrict the use of alcohols as a motor fuel are being examined. Infrastructure issues are being defined. Fuel formulation issues are being investigated and demonstration projects are being initiated. The work with the largest visibility are the demonstration projects, many of which involve ethanol powered buses. Emission tests are being conducted on a number of these demonstration vehicles. This paper describes the variety of projects that are underway. In instances where results are available, summary data is presented.

6159 (DOE/CH/10093–245, pp. 142-153) **The development of a heavy-duty methanol engine for low NO_x emissions.** Bartunek, B. (FEV Motorentechnik GmbH & Co. KG, Aachen (Germany)); Schorn, N.; Scholz, V.; Last, R.J. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

A global deterioration in air quality, particularly in urban areas is occuring despite more restrictive emissions standards. Additionally, a general increase in emissions of green house gases may compound this problem. The need for mitigation of these concerns has become a driving force in support of lean burn methanol combustion technology due to the anticipated beneficial environmental impact associated with the use of this fuel and combustion technology. The feasibility and potential for low HC. CO. particulate and aldehyde emissions of a diesel derived, hot surface ignition (HSI) ethanol engine has previously been demonstrated. The operational behavior of the Navistar DT-166 methanol engine demonstrated that the stringent 1994 U.S. emissions standards can be easily achieved with this alternative engine technology. This publication presents the latest results in the engine development program and outline the potential of the HSI methanol engine concept to meet future emission standards. In particular, the influence of the application of EGR on the performance and emissions of the methanol engine are presented and discussed. The development of an EGR strategy is outlined and the importance and influence of the fuel specification are considered. An assessment of the impact of these development steps is attempted through the use of a computer based transient test simulation procedure.

6160 (DOE/CH/10093–245, pp. 154-160) **M85 vehicles in the SCAQMD CleanFleet demonstration.** Krenelka, T.C. (Battelle Memorial Institute, Columbus, OH (United States)). National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The CleanFleet demonstration now has 111 alternative fuels vans in daily package delivery service with Federal Express. This includes 20 vehicles running on M85 methanol. The vehicles have been in service about a year, and have accumulated over 400,000 kilometers. On the whole, they have been very successful and reliable. The bulk fuel storage and dispensing system was the source of some fuel contamination, and was fixed. The vehicle fuel tank pickup tube/fuel pump assembly had a design problem, and the fleet has been updated to an improved design par. The trucks have been emissions tested, and will continue in service through October 1994.

6161 (DOE/CH/10093–245, pp. 187-195) **Catalysis for control of automotive emissions.** Ruixian Luo (Beijing Institute of Chemical Technology, Beijing (China)); Zhngli Lui; Renyou Zhang. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

This paper provides information on the purity of exhaust emission from gasoline-fueled and methanol-fueled automobiles.As the use of alcohol-fueled vehicles grows, effective catalytic control of emissions from these vehicles is becoming increasingly important The emissions from alcohol-fueled vehicles contain the unburned fuel and CO, but the number of partially oxidized fuel derivatives are much smaller compared to gasoline combustion. Since complex hydrocarbons, sulfur, and lead are absent from the exhaust, nonprecious transition metal oxide can offer an effective and inexpensive catalysis. This research examines the catalytic activity for oxidation of methanol, CO, and CH_4 over a series of transition metal (e.g., Cu, Mn, CO) oxide catalysts. These catalysts were prepared by the wet impregnation method and were all supported on transitional alumina. The BET surface area (BET) measurement and Scanning Electron Microscopy (SEM) were used to characterize the catalyst and support.The absorption and desorption behaviors of Co, CH_3OH, and O_2 on the catalysts were studied, and the reaction mechanism was suggested by using the transient response method.

6162 (DOE/CH/10093–245, pp. 225-234) **Vegetable alcohol fuel production and utilization in Hungary.** Jori, I.J. (Hungarian Institute of Agricultural Engineering, Gyor (Hungary)). National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The yield of bio-ethanol production from vegetable crops (like corn, sugar beets, potatoes, and recently, sweet sorghum) could be 1.0-1.5 tons of oil equivalent per hectare (tOE/ha) under good conditions in Hungary. Considering our arable land use for energy crops, the total bio-ethanol production could be 0.5-1.0 million tOE. In order to utilize this capacity, we have made laboratory and field tests with a mixture of 10% ethyl-alcohol, 15% water, 1.2% emulsifier, and diesel fuel. The results of a MTZ-80 tractor (with a type D-240 engine) tests shown that specific fuel consumption decreases 0%-4% at heavy loads and increases 0%-6% at light loads. During the field test (up to 1200 hours), there were no serious problems with the engine. We are currently preparing a project to develop an environmentally friendly production facility to satisfy multiple goals. The main goals of the new project are: (1) Choosing the new crop varieties (e.g., sweet sorghum); (2) Developing and environmentally friendly alcohol production technology; (3) Producing alcohol for human and industrial consumption; (4) Producing bio-ethanol; (5) Utilizing the by-products (e.g., molasses) for crop production and animal husbandry; (6) using surplus arable land and decreasing the number of unemployed farmers in the rural region.

6163 (DOE/CH/10093–245, pp. 235-243) **Total fuel cycle emissions analysis of biomass-ethanol transportation fuel.** Riley, C.J. (National Renewable Energy Lab., Golden, CO (United States)); Tyson, K.S. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The National Energy Strategy (NES) and the Clean Air Act Amendments (CAAA) of 1990 support the development of alternative transportation fuels including oxygenates for reformulated gasoline. The U.S. Department Energy (DOE) chose ethanol produced from lignocellulosic biomass as a high-priority option for research and development. Biomass includes lignocellulosic crops such as trees, grasses, and organic wastes. Ethanol from grain is not discussed in this paper. At the request of DOE, a fuel cycle analysis was completed to quantify the inputs and outputs of a hypothetical biomass-ethanol industry in the year 2010, and to compare the results to a similar analysis of reformulated gasoline. This paper is an excerpted summary of selected results from the final study Fuel Cycle Evaluations of Biomass-Ethanol and Reformulated Gasoline Fuels, Volumes I and II.

6164 (DOE/CH/10093–245, pp. 244-254) **Energy and crude oil input requirements for the production of reformulated gasolines.** Singh, M. (Argonne National Lab., Washington, DC (United States)); McNutt, B. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The energy and crude oil requirements for the production of reformulated gasolines (RFG) are estimated. Both the energy and crude oil embodied in the final product and the process energy required to manufacture the RFG and its components are included. The effect on energy and crude oil use of using various oxygenates to meet the minimum oxygen content level required by the Clean Air Act Amendment are evaluated. The analysis illustrates that production of RFG requires more total energy than that of conventional gasoline but uses less crude oil. The energy and crude oil use requirements of the different RFGs vary considerably. For the same emissions performance level, RFG with ethanol requires substantially more total energy and crude oil than RFG with MTBE or ETBE. A specific proposal by the EPA designed to allow the use of ethanol in RFG would increase the total energy required to produce RFG by 2% and the total crude oil required by 2.0 to 2.5% over that for the base RFG with MTBE.

6165 (DOE/CH/10093–245, pp. 255-271) **The life of fuels.** Ekelund, M. (Ecotraffic R&D AG (Sweden)). National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Although an interesting concept, a zero emission vehicle (ZEV) does not and cannot exist. There is no use of energy or use of resource that does not have an environmental impact, either before, during, or after its use in a vehicle. Admittedly, application of different technologies in engines and vehicles may alter the environmental impact that the use of energy creates. Consideration must also be given to the environmental impact resulting from the series of activities that occur prior to the resource becoming a fuel and delivery of the fuel to the end user. By examining the activities that occur during resource production, extraction, conversion/processing, refining, cultivating, and compressing, one may obtain a new perspective on which resource and which end-use technology offers: (1) Energy efficiency; (2) The best use of different fuels from the point of view of (a) The local environment, (b) Global warming, (c) Resource use (sustainability), (d) Technology. This paper examines 16 different fuels from "cradle to grave." The base case conditions used in this study are particular to Sweden, although most of these conditions are not too different from those in other.

6166 (DOE/CH/10093–245, pp. 275-280) **ETBE: Ecofuel's experience.** National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

Ecofuel is one of the world leaders in the Oxygenates. It is owned by Agip Petroli and is part of ENI, the Italian Energy Concern recently transformed in to a Stock Company to be quoted in the near future in the stock market according to the Government policy of privatization. Ecofuel was funded seven years ago to deal with the business of Oxygenates, a line of products for which ENI had a large and pioneer experience, having built and operated the

first MTBE plant in the world, a unit in Ravenna, in Italy on the Adriatic sea, started in 1973. Since the beginning of its life, Ecofuel has had to deal with Ethanol, a product strongly promoted not only in the USA, but periodically in Europe too, by agricultural lobbies. While confirming that Ecofuel clients are against the direct blending of Ethanol to gasoline, due to the well known problems of fuel stability in presence of water, high vapor pressure and so on, we have found that a good solution is the utilization of Ethanol instead of Methanol in the traditional Ether production, that is, the production of ETBE. Ecofuel has started its experience in this line in 1992, with a first limited production of ETBE in its Ravenna plant. The experience has been totally positive and we are now ready to extend it in all our facilities worldwide.

6167 (DOE/CH/10093–245, pp. 283-295) **The Energy Policy Act of 1992: An overview with a perspective to alcohol transportation fuels.** Stamper, K.R. (National Renewable Energy Lab., Golden, CO (United States)); Mallgrave, F.X. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The Energy Policy Act of 1992 was signed into law on October 24, 1992, signaling a significant commitment from the U.S. Government of stimulate the private sector to manufacture and provide fuel for Alternative Fuel Capable (AFC) vehicles. The most prolific purchaser and operators of AFC vehicles, in the scenario created by the Act, is the Federal, State and Local governments. The paper will examine the thrust of statute and describe DOE's plans to implement the provisions which relate to alternative transportation fuels.

6168 (DOE/CH/10093–245, pp. 296-318) **An evaluation of ethanol/ether blends in gasoline.** Davis, B.C. (Sun Company, Inc., Philadelphia, PA (United States)); Sneller, T.C. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The following information is in support of a proposed fuel waiver application. The proposed waiver application will seek EPA approval for a mixture of ethanol and various ethers in combinations up to 3.7% oxygen by weight. The preliminary information gathered to date was derived from a variety of sources. Additional technical input and data are being solicited from industry sources in an effort to develop a comprehensive application. Initial data has been developed by the State of Nebraska with technical assistance provided by Mr. Walt Douthit. Technical assistance has also been provided by the Oxygenated Fuels Association. Financial support for this effort has been provided by the State of Nebraska and the United States Department of Agriculture.

6169 (DOE/EE–0033) **Federal alternative motor fuels program – Light duty federal vehicles, trucks, and buses: Third annual report to Congress for fiscal year 1993.** USDOE Assistant Secretary for Energy Efficiency and Renewable Energy, Washington, DC (United States). Office of Transportation Technologies. Sep 1994. 124p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003982. Source: OSTI; NTIS; GPO Dep.

This annual report to Congress details the Federal light-duty alternative fuel vehicle operations from October 1992 through September 1993 as required by Section 400AA(b)(1)(B) of the Energy Policy and Conservation Act, 42 U.S.C. 6374(b)(1)(B). Also included are results of the first year of the Alternative Fuels Truck Commercial Application Program and the Alternative Fuels Bus Program activities required by sections 400BB and 400CC, respectively, of the Energy Policy and Conservation Act (42 U.S.C. 6374a and 6374b). The research that is associated with these projects is coordinated by the US Department of Energy (DOE), Office of Transportation Technologies, through the National Renewable Energy Laboratory (NREL). Significant expansion of the Alternative Motor Fuels Program data collection efforts occurred during fiscal year 1993 with the addition of more alternative fuel vehicles, test sites, and Federal agency involvement. In addition, the heavy-duty and bus projects required by the Energy Policy and Conservation Act have developed to the point where data are available for reporting. The locations of the Federal light-duty, heavy-duty truck, and bus vehicles that are participating in the data collection program are identified.

6170 (KFB-INFO–94-12) **Alcohol and biogas - realistic fuels for cars, buses and trucks?.** Swedish Transport and Communications Research Board, Stockholm (Sweden). Aug 1994. 7p. Order Number DE95723961. Source: OSTI; NTIS.

This paper gives a short overview of work going on in Sweden on biobased fuels for road transport vehicles, mainly absolute alcohol, blended fuels, and biogas.

35 ARMS CONTROL

3501 Policy, Negotiations, and Legislation

6171 (LA-UR–94-3867) **Los Alamos National Laboratory scientific interactions with the Former Soviet Union.** White, P.C. Los Alamos National Lab., NM (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9408173–2: 19. session of the international seminars on planetary emergencies, Erice (Italy), 19-24 Aug 1994). Order Number DE95003700. Source: OSTI; NTIS; INIS; GPO Dep.

The Los Alamos National Laboratory has a wide-ranging set of scientific interactions with technical institutes in the Former Soviet Union (FSU). Many of these collaborations, especially those in pure science, began long before the end of the Cold War and the breakup of the Soviet Union. This overview will, however, focus for the most part on those activities that were initiated in the last few years. This review may also serve both to indicate the broad spectrum of US government interests that are served, at least in part, through these laboratory initiatives, and to suggest ways in which additional collaborations with the FSU may be developed to serve similar mutual interests of the countries involved. While most of the examples represent programs carried out by Los Alamos, they are also indicative of similar efforts by Lawrence Livermore National Laboratory and Sandia National Laboratories. There are indeed other Department of Energy (DOE) laboratories, and many of them have active collaborative programs with FSU institutes. However, the laboratories specifically identified above are those with special nuclear weapons responsibilities, and thus have unique technical capabilities to address certain issues of some importance to the continuing interests of the United States and the states of the Former Soviet Union. Building on pre-collapse scientific collaborations and contacts, Los Alamos has used the shared language of science to build institutional and personal relationships and to pursue common interests. It is important to understand that Los Alamos, and the other DOE weapons laboratories are federal institutions, working with federal funds, and thus every undertaking has a definite relationship to some national objective. The fertile areas for collaboration are obviously those where US and Russian interests coincide.

3502 Proliferation

Refer also to citation(s) 6171

3503 Verification

Refer also to citation(s) 6495, 6524, 6525

6172 (LA-UR–93-3839) **Proceedings of the Numerical Modeling for Underground Nuclear Test Monitoring Symposium.** Taylor, S.R.; Kamm, J.R. (eds.). Los Alamos National Lab., NM (United States). Nov 1993. 404p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-930397–: Numerical modeling for underground nuclear test

monitoring symposium, Durango, CO (United States), 23-25 Mar 1993). Order Number DE95003509. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of the meeting was to discuss the state-of-the-art in numerical simulations of nuclear explosion phenomenology with applications to test ban monitoring. We focused on the uniqueness of model fits to data, the measurement and characterization of material response models, advanced modeling techniques, and applications of modeling to monitoring problems. The second goal of the symposium was to establish a dialogue between seismologists and explosion-source code calculators. The meeting was divided into five main sessions: explosion source phenomenology, material response modeling, numerical simulations, the seismic source, and phenomenology from near source to far field. We feel the symposium reached many of its goals. Individual papers submitted at the conference are indexed separately on the data base.

6173 (LA-UR–94-3871) **A review of broadband regional discrimination studies of NTS explosions and western US earthquakes.** Taylor, S.R. Los Alamos National Lab., NM (United States). [1994]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950151–1: NATO (ASI)/monitoring a comprehensive test ban treaty, Algrave (Portugal), 23 Jan - 2 feb 1995). Order Number DE95003699. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Verification of a Comprehensive Test Ban Treaty (CTBT) will require the use of regional-distance seismic stations. One important aspect of regional seismic monitoring involves the discrimination of nuclear explosions from other sources such as earthquakes and mining events (e.g. industrial explosions and rockbursts). In this paper, we review earthquake/nuclear explosion discrimination studies in the western US using broad-band seismic data. These studies are important because they are the only ones involving nuclear explosions and other sources in a single geophysical region having excellent ground truth information and a substantial historic database. Additionally, because of access to information from the NTS, much can be learned about the physical basis of regional discriminants. Using multivariate discrimination techniques, it was found, that approximately 96 % of the events analyzed could be correctly identified down to about magnitude 3.5. Most of the events misidentified were recorded with poor signal-to-noise ratio at only a minimal number of stations. However, a few well-recorded events were misclassified for one or more discriminants. Examples of detailed analysis of a missed violation (nuclear explosion that looks like an earthquake) and a false alarm (naturally occurring event that looks like an explosion) are illustrated. Resolution of anomalous events such as these will be critical to CTBT monitoring.

36 MATERIALS

Refer also to citation(s) 6647

6174 (LA-UR–91-3961) **Center for Materials Science, Los Alamos National Laboratory. Status report, October 1, 1990–September 30, 1991.** Parkin, D.M.; Boring, A.M. (comps.). Los Alamos National Lab., NM (United States). 1 Oct 1991. 198p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003506. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the progress of the Center for Materials Science (CMS) from October 1, 1990 to September 30, 1991, and is the nineth such annual report. It has been a year of remarkable progress in building the programs of the Center. The extent of this progress is described in detail. The CMS was established to enhance the contribution of materials science and technology to the Laboratory's defense, energy and scientific missions, and the Laboratory. In carrying out these responsibilities it has accepted four demanding missions: (1) Build a core group of highly rated, established materials scientists and solid state physicists. (2) Promote and support top quality, interdisciplinary materials research programs at Los Alamos. (3) Strengthen the interactions of materials science and Los Alamos with the external materials science community. and (4) Establish and maintain modern materials research facilities in a readily accessible, central location.

6175 (ORNL–6816) **Solid State Division progress report for period ending September 30, 1993.** Green, P.H.; Hinton, L.W. (eds.). Oak Ridge National Lab., TN (United States). Aug 1994. 301p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003900. Source: OSTI; NTIS; INIS; GPO Dep.

This report covers research progress in the Solid State Division from April 1, 1992, to September 30, 1993. During this period, the division conducted a broad, interdisciplinary materials research program with emphasis on theoretical solid state physics, neutron scattering, synthesis and characterization of materials, ion beam and laser processing, and the structure of solids and surfaces. This research effort was enhanced by new capabilities in atomic-scale materials characterization, new emphasis on the synthesis and processing of materials, and increased partnering with industry and universities. The theoretical effort included a broad range of analytical studies, as well as a new emphasis on numerical simulation stimulated by advances in high-performance computing and by strong interest in related division experimental programs. Superconductivity research continued to advance on a broad front from fundamental mechanisms of high-temperature superconductivity to the development of new materials and processing techniques. The Neutron Scattering Program was characterized by a strong scientific user program and growing diversity represented by new initiatives in complex fluids and residual stress. The national emphasis on materials synthesis and processing was mirrored in division research programs in thin-film processing, surface modification, and crystal growth. Research on advanced processing techniques such as laser ablation, ion implantation, and plasma processing was complemented by strong programs in the characterization of materials and surfaces including ultrahigh resolution scanning transmission electron microscopy, atomic-resolution chemical analysis, synchrotron x-ray research, and scanning tunneling microscopy.

3601 Metals and Alloys

Refer also to citation(s) 5078, 5079, 5334, 5341, 5343, 5677, 5700, 5701, 5925, 5952, 6315, 6363, 6365, 6423, 6455

6176 (ANL/MSD/CP–83328) **Neutron diffraction study of radiation damage in U_3Si at 30°C and 350°C.** Birtcher, R.C.; Richardson, J.W. Jr.; Mueller, M.H. Argonne National Lab., IL (United States). Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-941144–18: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95004137. Source: OSTI; NTIS; INIS; GPO Dep.

Neutron diffraction has been used to follow damage evolution in U_3Si produced by neutron irradiation at 30°C and 350°C. Increasing neutron irradiation dose at 30°C results in monotonic expansion of the a-axis and contraction of the c-axis that transforms the crystal structure from tetragonal to cubic. Additional irradiation results in amorphization. Neutron irradiation at 350°C results in little change to the a-axis and expansion of the c-axis. The complete alteration in lattice dilatation during irradiation is interpreted as due to modification of surviving defect configurations at the higher temperature. The high temperature lattice dilations can be explained by defect loop formation in the a-b plane. TEM observations have shown that ion irradiation at temperatures below 280°C results in amorphization while twin boundaries dissolve and new subgrains form at higher temperatures. Confinement of lattice strain to the c-axis during irradiation at 350°C may be the mechanism that prevents the total lattice dilatation from exceeding the critical level required for amorphization. High-density uranium silicides have potential uses in the nuclear industry for use in high power or low enrichment applications. However, U_3Si exhibits a mechanical instability during reactor irradiation that results in catastrophic swelling. Such behavior would preclude use of these materials as reactor fuels.

6177 (ANL/MSD/CP–84783) **Resonant photoemission studies of thickness dependence of the unoccupied Gd 5d bands.** Dowben, P.A. (Univ. of Nebraska, Lincoln, NE (United States). Dept. of Physics); Zhang, J.; Li, D.; Onellion, M. Argonne National Lab., IL (United States). Materials Science Div. [1994].

14p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-31109-ENG-38. NSF Grant DMR-92-21655. (CONF-941001–8: 41. annual American Vacuum Society symposium, Denver, CO (United States), 24-28 Oct 1994). Order Number DE95004127. Source: OSTI; NTIS; INIS; GPO Dep.

Ultrathin Gd films have been studied with constant initial-state spectroscopy (CIS) of photoemission utilizing linearly polarized light of synchrotron radiation. The photoemission cross-section of the 5d surface state near E_F shows strong photon energy dependence, i.e. sharp peaks in CIS spectra near the Gd $5p_{1/2}$ adsorption edge. These peaks originate from resonant photoemission processes involving the occupied 5p and unoccupied 5d levels of the surface atoms. The symmetry of the unoccupied states were determined experimentally by changing the polarization of light, where p-polarized light excites only to the unoccupied d_{z^2} or $d_{xz,yz}$ states and s-polarized light to all the d states including $d_{x^2-y^2}$ and d_{xy} states. Based on the symmetry assignments, the lower bound of the exchange splitting of the Gd $5d_{z^2}$ surface state can be abstracted, which increases when the thickness of Gd film decreases and reach maximum at the monolayer limit.

6178 (CONF-940440–5) **Cu deposition using a permanent magnet electron cyclotron resonance microwave plasma source.** Berry, L.A.; Gorbatkin, S.M.; Rhoades, R.L. Oak Ridge National Lab., TN (United States). [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From International conference on metallurgical coatings and thin films; San Diego, CA (United States); 25-29 Apr 1994. Order Number DE94017768. Source: OSTI; NTIS; GPO Dep.

An electron cyclotron resonance (ECR) plasma has been used in conjunction with a solid metal sputter target for Cu deposition over 200-mm diameters. The goal is to develop a deposition process suitable for filling submicron, high aspect ratio features used for ultralarge scale integration. The system uses a permanent magnet for creation of the magnetic field necessary for ECR and is significantly more compact than systems equipped with electromagnets. A custom launcher design allows remote microwave injection with the microwave entrance window shielded from the Cu flux. Cu deposition rates up to 100 nm/min were observed and film resistivities were typically in the low to mid 2 μohm-cm range. Based on deposition rate measurements at two radial sample position, uniformities of a few % over 200-mm diameters should be attainable.

6179 (DOE/ID/13220–T2) **Magnetically controlled deposition of metals using gas plasma. Quarterly progress report, July 1994–September 1994.** Idaho National Engineering Lab., Idaho Falls, ID (United States). [1995]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG07-93ID13220. Order Number DE95003827. Source: OSTI; NTIS; INIS; GPO Dep.

This document reports the status of grant DE-FE07-93ID13220 for the July-September, 1994 quarter. The objective of this grant is to develop a method of spraying materials on a substrate in a controlled manner to eliminate the waste inherent in the present process. Thin layers of secondary material are plated on substrates either by plating or spraying processes. Plating operations produce large amounts of hazardous liquid waste. Spraying, while one of the less waste intensive methods, produces 'over spray' which is waste that is a result of the uncontrolled nature of the spray stream. In many cases the over spray produces a hazardous waste.

6180 (ETDE/DE-mf–95733403) **High temperature low cycle fatigue in flue gas atmosphere.** Rie, K.T.; Klingelhoeffer, H. Technische Univ. Braunschweig (Germany). Inst. fuer Oberflaechentechnik und Plasmatechnische Werkstoffentwicklung. [1993]. 13p. Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0326335D. Order Number DE95733403. Source: OSTI; NTIS (US Sales Only).

High temperature low cycle fatigue tests were performed at 920 C in air and flue gas on Incoloy 800 H. It was observed that fatigue life was influenced differently depending on the environment. In flue gas a strong internal corrosion in form of nitridation and sulfidation was found at the crack tip. The mechanisms leading to the internal corrosion were explained and their effect on fatigue life was discussed. (orig.)

6181 (JAERI-Research–94-015) **Irradiation experiments of low copper A533B steels for reactor pressure vessel tested in JMTR.** Suzuki, Masahide (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Onizawa, Kunio; Kizaki, Minoru. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1994. 79p. Order Number DE95737266. Source: OSTI; NTIS; INIS.

Irradiation embrittlement of A533B steels with low copper contents was investigated from the point of dose rate and irradiation temperature effects. Changes of neutron flux in the range from $\approx 10^{12}$ to $\approx 10^{13}$ n/cm^2/s (E>1 MeV) did not have a significant effect on the embrittlement. Irradiation temperature change of 1degC resulted in the transition temperature shift (ΔT_{41J}) of about 1degC and yield stress change ($\Delta\sigma_y$) of about 0.8MPa. Factors that might affect the embrittlement of low copper steels are also discussed. (author).

6182 (JAERI-Research–94-022) **In-situ measurement of zircaloy corrosion rate in high temperature, high pressure water.** Suzuki, Motoe (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1994. 42p. (In Japanese). Order Number DE95737274. Source: OSTI; NTIS; INIS.

In-situ measurement of corrosion rate of Zircaloy-4 was tested by applying AC-impedance method in 300degC water in a static autoclave. Impedance data of surface oxide layer of sample were obtained by the Frequency Response Analysis Method and converted into the corrosion rate, and were compared with a theoretical prediction. The results led to the conclusion that the present method permits in-situ measurement of the corrosion rate. It was also found that degradation of water quality affects the data to a considerable extent, and that the impedance data indicate the property change of the double-layer structure of oxide. (author).

6183 (KCP–613-4808) **Investigation of arc length versus flange thickness while using an arc voltage controller.** Daumeyer, G.J. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Nov 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. Order Number DE95003937. Source: OSTI; NTIS; GPO Dep.

An arc voltage controller (AVC) for gas tungsten arc welding will change arc length when flange thickness changes while all other variables, including AVC setting, are held constant. A procedure for calibrating an LVDT (linear variable displacement transducer) used for electrode assembly motion monitoring was proven for laboratory setups and special investigations. A partial characterization on the deadband and sensitivity control settings of the Cyclomatic AVC was completed.

6184 (KCP–613-4884) **Progress report on a fully automatic Gas Tungsten Arc Welding (GTAW) system development.** Daumeyer, G.J. III. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Dec 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. Order Number DE95004397. Source: OSTI; NTIS; GPO Dep.

A plan to develop a fully automatic gas tungsten arc welding (GTAW) system that will utilize a vision-sensing computer (which will provide in-process feedback control) is presently in work. Evaluations of different technological aspects and system design requirements continue. This report summaries major activities in the plan's successful progress. The technological feasibility of producing the fully automated GTAW system has been proven. The goal of this process development project is to provide a production-ready system within the shortest reasonable time frame.

6185 (KCP–613-5302) **Vision-sensing image analysis for GTAW process control.** Long, D.D. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Nov 1994. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. Order Number DE95003936. Source: OSTI; NTIS; GPO Dep.

Image analysis of a gas tungsten arc welding (GTAW) process was completed using video images from a charge coupled device (CCD) camera inside a specially designed coaxial (GTAW) electrode holder. Video data was obtained from filtered and unfiltered images, with and without the GTAW arc present, showing weld joint features and locations. Data Translation image processing boards, installed in an IBM PC AT 386 compatible computer, and Media Cybernetics image processing software were used to investigate edge flange weld joint geometry for image analysis.

6186 (LA–12858-MS) **Evolution of plastic anisotropy for high-strain-rate computations.** Schiferl, S.K.; Maudlin, P.J. Los Alamos National Lab., NM (United States). Dec 1994. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95004220. Source: OSTI; NTIS; GPO Dep.

A model for anisotropic material strength, and for changes in the anisotropy due to plastic strain, is described. This model has been developed for use in high-rate, explicit, Lagrangian multidimensional continuum-mechanics codes. The model handles anisotropies in single-phase materials, in particular the anisotropies due to crystallographic texture–preferred orientations of the single-crystal grains. Textural anisotropies, and the changes in these anisotropies, depend overwhelmingly no the crystal structure of the material and on the deformation history. The changes, particularly for a complex deformations, are not amenable to simple analytical forms. To handle this problem, the material model described here includes a texture code, or micromechanical calculation, coupled to a continuum code. The texture code updates grain orientations as a function of tensor plastic strain, and calculates the yield strength in different directions. A yield function is fitted to these yield points. For each computational cell in the continuum simulation, the texture code tracks a particular set of grain orientations. The orientations will change due to the tensor strain history, and the yield function will change accordingly. Hence, the continuum code supplies a tensor strain to the texture code, and the texture code supplies an updated yield function to the continuum code. Since significant texture changes require relatively large strains–typically, a few percent or more–the texture code is not called very often, and the increase in computer time is not excessive. The model was implemented, using a finite-element continuum code and a texture code specialized for hexagonal-close-packed crystal structures. The results for several uniaxial stress problems and an explosive-forming problem are shown.

6187 (LA-UR–94-3726) **Experimental and theoretical studies on the C15 intermetallic compounds MV_2 (M = Zr, Hf and Ta): Elasticity and phase stability.** Chu, F. (Los Alamos National Lab., NM (United States)); Mitchell, T.E.; Chen, S.P.; Sob, M.; Siegl, R.; Pope, D.P. Los Alamos National Lab., NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. Grant N00014-91-J-1165P02. (CONF-941144–16: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003723. Source: OSTI; NTIS; INIS; GPO Dep.

The phase stability of C15 HfV_2 was studied by specific heat measurements. The elastic constants of C15 HfV_2 were measured by the resonant ultrasound spectroscopy. Total energy and electronic structure of C15 intermetallic compounds MV_2 (M = Zr, Hf and Ta) were calculated using the linear muffin tin orbital (LMTO) method. The band structures at X-point near the Fermi level were used to understand the anomalous shear moduli of the C15 HfV_2 and ZrV_2. It was found that the double degeneracy with a linear dispersion relation of electronic levels at the x-point near the Fermi surface is mainly responsible for the C15 anomalous elasticity at high temperatures. The densities of states at Fermi level and the geometry of the Fermi surface were used to explain the low temperature phase instability of C15 HfV_2 and ZrV_2 and the stability of C15 TaV_2. The relationship between the anomalous elasticity and structural instability of C15 HfV_2 and ZrV_2 were also studied.

6188 (LA-UR–94-3956) **Theoretical and experimental studies on the C15 intermetallic compound $NbCr_2$.** Chu, F. (Los Alamos National Lab., NM (United States)); Thoma, D.J.; He, Y.; Mitchell, T.E.; Chen, S.P.; Perepezko, J.H. Los Alamos National Lab., NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–10: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003665. Source: OSTI; NTIS; INIS; GPO Dep.

The electronic structure and total energy of the C15 $NbCr_2$ have been calculated using the linear muffin-tin orbital (LMTO) method with the atomic sphere approximation (ASA). The total energy vs. volume curve, band structure, density of states and Fermi surface were obtained. The calculated results were used to examine several features of the C15 phase, including the elastic properties, phase formation and stability, and solubility of the C15 phase. The theoretical results are compared to experimental studies on the C15 $NbCr_2$ phase. For example, the elastic moduli, phase stability, and homogeneity range have been characterized with a variety of experimental techniques. Comparison of the experimental and theoretical results will be discussed.

6189 (LA-UR–94-4081) **The temperature and strain rate dependence of the flow stress of single crystal NiAl deformed along <110>.** Maloy, S.A.; Gray, G.T. III. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–6: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003634. Source: OSTI; NTIS; GPO Dep.

Single crystal NiAl and Ni-49.75Al-0.25Fe have been deformed along <110> at temperatures of 77, 298 and 773K and strain rates of 0.001/s, and 2000/s. The flow stress of <110> NiAl is rate and temperature sensitive. The 0.25 at.% Fe addition resulted in a small increase in flow stress at strain rates of 0.001 and 0.1/s at 298 and 77K. A significant decrease in the work hardening rate is observed after deformation at 77K and a strain rate of 2000/s. Coarse [110] slip traces are observed after deformation at a strain rate of 2000/s at 77K, while no slip traces were observed after deformation under all other conditions. TEM observations reveal distinct [110] slip bands after deformation at 77K and a strain rate of 2000/s.

6190 (LA-UR–94-4084) **Deformation of C15 Laves phase alloys.** Chu, F.; Pope, D.P. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Grant N00014-91-V-1165. (CONF-941144–2: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003636. Source: OSTI; NTIS; GPO Dep.

Details of the structure and previous work on the deformation of C Laves phases are reviewed. The phase diagram of the Hf-V-Nb system, some metallurgical and physical properties, mechanical behavior, and the deformation mechanisms of HfV_2+Nb (Cl5 HfV_2+Nb and V-rich bcc solution) are presented based on our previous work. Theoretical approaches to understanding the results of these studies are discussed.

6191 (NEI-NO–460) **Modeling of recrystallization applied to commercial aluminium alloys.** Furu, T. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. Sep 1992. 180p. Order Number DE95723911. Source: OSTI; NTIS.

A comprehensive study of the annealing behavior of some non heat-treatable commercial aluminium alloys has been carried out. The primary objective of this work has been to establish a detailed knowledge of the recovery and recrystallization processes occurring during annealing of heavily deformed metals, from both an experimental and a modeling point of view. The experimental part has focused on the evolution in stored energy and mechanical properties as well as the kinetics of recovery and recrystallization during annealing. The modeling part has dealt with the construction of a computer model based on physical metallurgical principles for describing the kinetic aspects of both recovery and recrystallization. The time dependency of recrystallization, described in terms of the JMAK-exponent (Johnson-Mehl-Avrami-Kolmogorov) has been followed for a range of annealing temperatures, strains and alloys. The results revealed for all these variants JMAK-exponents of about 2, which are much lower than the classical values of 3 and 4 for three dimensional homogenous site saturation and

Johnson-Mehl- kinetics, respectively. A recrystallization model has been developed, which consists of the following main features: Nucleation sites are distributed approximately randomly in space; Nucleation of new grains is site saturated; The growth rate of the recrystallized grains decreases with time according to either the deformation zones associated with large undeformable particles or concurrent recovery simultaneous with the recrystallization process. The modeling results have shown that introducing a decreasing growth rate due to deformation zones decreases the JMAK-exponent to a value which corresponds to the experimental JMAK-values. 112 refs., 88 figs., 2 tabs.

6192 (NEI-NO–462) **Crust formation in cryolite based baths.** Rye, K.Aa. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. Apr 1992. 231p. Order Number DE95723938. Source: OSTI; NTIS.

In this work crust samples were made in the laboratory. In the experimental part of this work it is shown that the crust formation is a heat transfer controlled process. Hence, the rate of penetration of bath into the loose alumina during crust formation is determined by the thermal diffusivity of the crust and the alumina. In the experiments a typical value for the rate of penetration was 0.5 mm/min for the lower part of the crust. The rate of penetration decreased as the crust thickness approached steady state, which was obtained after three to four hours. The bath phase inside the crust was partly liquid and partly solid, and it was shown that the bath segregated as it rose into the crust. Solid cryolite was precipitated in the lower parts of the crust, causing the remaining liquid bath to be enriched in AlF_3 and CaF_2. In the top of the crust the NaF/AlF_3 molar ratio (CR) of the bath phase had decreased to approximately 1.3, even though the CR of the bath flowing into the crust had a CR of approximately 2.4. A bath with a low CR deposited less solid cryolite inside the crust during formation than in crusts made with a bath with a normal CR. The proportion between liquid bath and solid cryolite was higher in all parts of crusts made with a low CR bath. It was hard to find experimental evidence that variations in the alumina parameters had any impact on the steady state thickness, overall density and overall thermal conductivity of crust. A statistical analysis of the experimental data indicated a lower crust thickness at high contents of fines and a high initial content of the alpha phase in the alumina. No significant correlations were found between the alumina parameters and the measured thermal conductivity of crust. A theoretical model indicated increasing thermal conductivity of crust with increasing content of fines in the range 0 to 35 wt%, however. 62 refs., 80 figs., 8 tabs.

6193 (ORNL/FMP–94/1, pp. 169-183) **Effect of heat treatment temperature on creep-rupture properties of Fe_3Al-based alloys.** McKamey, C.G. (Oak Ridge National Lab., TN (United States)); Maziasz, P.J. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The effects of heat treatment at 1100 to 1250°C on the creep-rupture properties of an Fe_3Al-based alloy were studied. Tests were conducted at 593°C (1100°F) and 207 MPa (30 ksi) in air. The modes of fracture were identified using optical metallography and scanning electron microscopy. Analytical electron microscopy was also used to study characteristics of the microstructure, including dislocations, ordered domains, and precipitates. The creep results showed maximum creep-rupture resistance with a heat treatment at approximately 1150°C, with significant decreases in rupture life after heat treatments at both lower and higher temperatures. The peak in creep life was associated with fine precipitates that were observed after the 1150°C heat treatment and persisted during prolonged creep at 593°C. Heat treatment at 1150°C appeared to cause dissolution of coarser precipitates which then reprecipitated as new fine particles upon cooling or during creep. These fine precipitates then pinned dislocations and grain boundaries to produce strength during creep.

6194 (ORNL/FMP–94/1, pp. 195-204) **Tensile properties of as-cast Fe_3Al-based alloys.** Viswanathan, S. (Oak Ridge National Lab., TN (United States)); McKamey, C.G.; Maziasz, P.J. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Room-temperature tensile properties of as-cast Fe_3Al-based FA-129 alloy were investigated. Tensile properties were obtained in the as-cast condition in air, oxygen, and water-vapor environments, and after homogenization at 700, 900, and 1200°C. Transmission electron microscopy (TEM) was used to characterize ordered phases and dislocation structure, and optical metallography and scanning electron microscopy (SEM) were used to characterize the grain microstructure and fracture morphology. Tensile properties in the as-cast conditions exhibited an environmental effect; tensile ductilities in oxygen atmosphere were greater than those obtained in laboratory air. Homogenized samples of FA-129 alloy exhibited almost twice the ductility found in the as-cast condition. Microstructural characterization of the homogenized samples and comparison of the as-cast and homogenized microstructures provided clues that helped to explain the poor ductility in the as-cast state.

6195 (ORNL/FMP–94/1, pp. 205-210) **Weldability of iron aluminides.** Goodwin, G.M. (Oak Ridge National Lab., TN (United States)); Maziasz, P.J.; McKamey, C.J.; DeVan, J.H.; Sikka, V.K. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Corrosion-resistant weldable iron aluminide alloys are being developed for weld overlay cladding of conventional steels and alloys and possible structural applications. Weld hot cracking can be minimized by careful choice of alloying additions, and hot cracking resistance equivalent to commercial austenitic stainless steels has been achieved. Hydrogen-induced cold cracking, however, continues to be a problem with these alloys, both in monolithic weldments and weld overlay cladding applications. We have found that preheat and postweld heat treatment can reduce hydrogen cracking, and that composition is also an important variable. Experiments in controlled atmospheres have confirmed that a major source of hydrogens is provided by the reduction of water vapor from the environment, and that oxygen helps to reduce cracking sensitivity. Concurrently, we are developing filler metals using the aspiration-casting process, for use both as filler metals with the gas tungsten arc process, and as core wire for the production of shielded metal arc electrodes.

6196 (ORNL/FMP–94/1, pp. 211-218) **Weldability of polycrystalline aluminides.** Fasching, A.A. (Colorado School of Mines, Golden, CO (United States)); Edwards, G.R.; David, S.A. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Water vapor present in the atmosphere during welding has been shown to cause fusion zone cold cracking in Fe_3Al alloys. Understanding the effect of water vapor concentration during welding is important to optimizing the welding parameters. Furthermore, the relationships between welding parameters, fusion zone microstructures, and cold cracking susceptibility must be understood if these advanced materials are to be effectively utilized. Preliminary studies have indicated that coarse-grained fusion zones for these alloys are the most susceptible to cold cracking. Because refined fusion zone microstructures are expected to exhibit superior properties, including resistance to cold cracking, a technique was developed to refine the fusion zone with magnetic arc oscillation during welding. The GTA welding of iron-aluminide alloy FA-129 sheet was conducted using a 225-amp water-cooled torch enclosed in a controlled-atmosphere glove box. A two-pole magnetic arc oscillator deflected the arc during welding in a direction either longitudinal to or transverse to the welding direction. Transverse arc oscillations resulted in more significant fusion zone refinement. Both arc oscillation amplitude and frequency were also found to affect grain

refinement; low frequency (25 Hz) and small amplitudes (1.5mm) were found to be most effective in reducing the average fusion zone grain size. A series of experimental welds, fabricated with arc oscillation to produce a range of fusion zone grain sizes, and with shielding gas containing a range of water vapor concentrations, is in progress. The threshold water vapor concentration, sufficient to cause cold cracking in each fusion zone microstructure, will be quantified.

6197 (ORNL/FMP–94/1, pp. 219-226) **Electro-spark deposited coatings for fossil energy environments.** Johnson, R.N. (Westinghouse Hanford Co., Richland, WA (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Electro-Spark Deposition (ESD) is a micro-welding process that uses short-duration, high-current electrical pulse to deposit or alloy an electrode material on a metallic substrate. The ESD process has been used to markedly improve the corrosion resistance and wear resistance of base metals by alloying appropriate materials into the surface. One of the most attractive developments has been the use of ESD to apply Fe_3Al-and FeAl-base materials to surfaces of iron alloys. The evolutionary developments of the aluminides as coatings include the further improvement in the sulfidation corrosion performance by the ESD addition of refractory metal diffusion barriers between the substrate metal and the aluminide coating and by ESD additions of modifying elements to an Fe_3Al or FeAl surface. Developments are now in progress on titanium aluminide based coatings and on ORNL's new Cr-Nb intermetallic materials. The titanium aluminides are showing significant promise as a coating material. The Cr-Nb alloys are being evaluated not only as material for coatings but also for production of nanometer-sized particles using a modification of the ESD process. Other advances include (1) the development of advanced robotics programs for automated ESD coating processes and (2) successful new applications being developed commercially through technology transfer activities.

6198 (ORNL/FMP–94/1, pp. 227-237) **High temperature corrosion of iron aluminides.** Natesan, K. (Argonne National Lab., IL (United States)); Cho, W.D. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract W-31109-ENG-38. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Iron aluminides are being developed for use as structural materials and/or cladding alloys in fossil energy systems. Extensive development has been in progress on Fe_3Al-based alloys to improve their engineering ductility. This paper describes results from an ongoing program to evaluate the corrosion performance of these alloys. The experimental program at Argonne National Laboratory involves thermogravimetric analyses of alloys exposed to environments that simulate coal gasification and coal combustion. Corrosion experiments were conducted to determine the effect of gas flow rate and different levels of HCl at a gas temperature of 650°C on three heats of aluminide material, namely, FA 61, FA 129, and FAX. In addition, specimens of Type 316 stainless steel with an overlay alloying of iron aluminide were prepared by electro-spark deposition and tested for their corrosion resistance. Detailed microstructural evaluations of tested specimens were performed. The results are used to assess the corrosion resistance of various iron aluminides for service in fossil energy systems that utilize coal as a feedstock.

6199 (ORNL/FMP–94/1, pp. 239-254) **Elastic behavior of nickel aluminide and iron aluminide-based intermetallics.** Srinivasan, M.N. (Texas A&M Univ., College Station, TX (United States)); Manjigani, S.; Wolfenden, A.; Sikka, V.K. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The elastic and torsion modulus of five different grades of nickel aluminide and four different grades of iron aluminide at different temperatures are reported in this paper. The instrument used for this purpose is the Piezoelectric Ultrasonic Composite Oscillator Technique (PUCOT).

6200 (ORNL/FMP–94/1, pp. 261-278) **Low-aluminum content iron-aluminum alloys.** Sikka, V.K. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

A newly developed melting method for Fe-16 at.% Al alloy (FAPY) is described. Tensile data on the air-induction-melted (AIM) and vacuum-induction-melted (VIM) heats of FAPY after identical processing are presented. Optical, scanning electron micrographs (SEM), and microprobe analysis were carried out to explain the lower room-temperature ductility and more scatter in the data for the AIM material as opposed to the VIM material.

6201 (ORNL/FMP–94/1, pp. 279-286) **The influence of processing on microstructure and properties of iron aluminides.** Wright, R.N. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Wright, J.K. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The influence of hot working and subsequent annealing on the microstructure and mechanical properties of iron aluminide alloy FA-129 have been examined using x-ray diffraction and transmission electron microscopy. It has been shown that the presence of defect substructure, even in the form of well developed low angle dislocation boundaries, retards the formation of DO_3 order on cooling from the B2 regime. The influence of processing on properties of iron alloys containing approximately 16 at.% Al has also been examined in detail and the relationship to the microstructure will be discussed. Reaction synthesis methods have been developed for joining alloy FA-129 and for producing porous iron aluminides for filter applications. Elemental powders or foils have been used to reactively join FA-129 with a Fe_3Al joint layer. The mechanism of bonding appears to be somewhat complex, however, it has been demonstrated that the joints formed from elemental powders are superior to those formed by reaction of elemental foils. The fine grained structure of joints formed from elemental powders results in joints that are stronger than the base material and tensile failure occurs in the base material away from the joint region. Prototype porous Fe_3Al filters formed by reaction synthesis have been produced and tested, showing flow characteristics suitable for filtering hot gas streams.

6202 (ORNL/FMP–94/1, pp. 287-296) **Fracture behavior of the Fe-8Al alloy FAP-Y.** Alexander, D.J. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The tensile and impact properties of two heats of the reduced aluminum alloy FAP-Y have been measured and compared to the Fe_3Al alloy FA-129. The FAP-Y material has similar yield strengths up to 400°C, and much better ductility and impact properties, as compared to the FA-129. Despite excellent room-temperature ductility, the ductile-to-brittle transition temperature is still quite high, around 150°C. The material is found to be strain-rate sensitive, with a significant increase in the yield strength at strain rates of about $10^3\ s^{-1}$. It is believed that this strain-rate sensitivity is responsible, at least in part, for the high ductile-to-brittle transition temperature.

6203 (ORNL/FMP–94/1, pp. 297-307) **Investigation of moisture-induced embrittlement of iron aluminides.** Castagna, A. (Rensselaer Polytechnic Institute, Troy, NY (United States));

Stoloff, N.S. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The influence of several gaseous environments (hydrogen gas, air, and oxygen) on the fatigue crack growth resistance and ductility of a disordered iron-aluminum alloy (FAP-Y) has been determined. Hydrogen gas is found to be most detrimental to crack growth resistance and ductility, while tests in oxygen reveal the lowest crack growth rates and highest ductility. Testing in air resulted in mechanical properties similar to those in oxygen. TEM analysis of dislocation substructures and SEM analysis of fractographic features will be discussed in the context of the mechanism of environmental embrittlement. The embrittling effect of hydrogen gas on FAP-Y is similar to that on a Fe-28a%Al ordered intermetallic, FA-129, which has been studied previously. The higher aluminum FA-129, however, is also severely embrittled by laboratory air, while FAP-Y is not. It was found that the low aluminum FAP-Y exhibits higher room temperature ductility than FA-129, but less resistance to fatigue crack growth.

6204 (ORNL/FMP–94/1, pp. 309-320) **Environmental effects on iron aluminide.** DeVan, J.H. (Oak Ridge National Lab., TN (United States)); Tortorelli, P.F.; Bennett, M.J. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Air oxidation tests of iron-aluminum alloys containing 16 and 28 atom % Al, respectively, were conducted at 1300°C to determine the effect of alloy composition and section thickness on the time to breakdown of oxidation resistance. The oxidation rates of the 16% Al alloy were significantly higher than for 28% Al (Fe_3Al) alloys. The times over which the oxide scales remained protective correlated with the extent of aluminum depletion of the alloy matrix and were therefore a direct function of the initial aluminum content of the alloy, the section thickness, and the oxidation rate. The oxidation rate of the Fe_3Al alloys was significantly reduced by the addition of 0.1% Zr, which improved the adherence of the scale during thermal cycling to room temperature. However, the oxidation rates of the Fe_3Al alloys were higher at 1300°C than those reported for oxide-dispersion-strengthened (ODS) Fe-18%Cr-10%Al alloys containing Y_2O_3. Times to the onset of breakaway oxidation were similar for zirconium-containing Fe_3Al and the ODS alloys, the lower oxidation rate of the latter offsetting the higher initial aluminum of the former. Studies of the effects of chlorine (HCl) on the oxidation/sulfidation resistance of Fe_3Al-based alloys were conducted using test facilities at the National Physical Laboratory (NPL) in the United Kingdom. Alloys were exposed to a test gas composed of CO_2, H_2, H_2O, and H_2S plus 1000-5000 ppm HCl at 450 and 550°C for 1000 h. Weight gains were relatively low and were generally less than companion specimens of Fe-Cr-Al alloys.

6205 (ORNL/FMP–94/1, pp. 321-330) **Localized corrosion and stress corrosion cracking characteristics of low-aluminum-content iron-aluminum alloys.** Kim, J.G. (Univ. of Tennessee, Knoxville, TN (United States)); Buchanan, R.A. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The aqueous corrosion behavior of FAPY, a new low-Al-content Fe-Al alloy (Fe-16.1Al-5.4Cr-1.1Mo-0.11C-0.11Zr-0.06Y, at.%), was studied in various electrolytes and compared with reference materials. Corrosion rates for FAPY were much closer to that of 304L stainless steel than to the plain-carbon and low-alloy steels evaluated. Three-week crevice corrosion tests were performed in chloride-containing solutions on FAPY, and for comparison on 304L stainless steel. The FAPY alloy was less resistant to crevice corrosion than the 304L stainless steel. In the 3.5 wt.% NaCl solution, the FAPY alloy was subject to severe crevice corrosion. Slow-strain-rate corrosion tests were conducted at the freely-corroding open-circuit potential and at potentiostatically-controlled anodic and cathodic potentials to evaluate the environmental-embrittlement susceptibility. It was found that the FAPY alloy was susceptible to hydrogen embrittlement and anodic-dissolution stress corrosion cracking, but at the freely-corroding and hydrogen-producing-cathodic potentials, the ductilities were significantly higher than those for Fe_3Al-based iron aluminides.

6206 (ORNL/FMP–94/1, pp. 331-341) **Interactions between creep and corrosion in alloy 800.** Natesan, K. (Argonne National Lab., IL (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract W-31109-ENG-38. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Metallic components within or immediately adjacent to gasifiers, such as gas distributors, thermowells, transfer lines, and cyclones, are subjected to particularly severe conditions of temperature, pressure, and hostile multicomponent gas environments. In addition, metallic heat exchangers/waste-heat boilers that are resistant to sulfidation, corrosion, and erosion in low- and medium-Btu gas environments are essential components in large-scale gasification schemes, in both dry ash and slagging type gasifiers. Components, in general, must be resistant to corrosion, erosion, and high-temperature creep. Refractory linings are conventionally employed to mitigate corrosion and erosion, and in some cases, internal cooling has been considered to avoid the problems associated with the interaction of high-temperature creep and fatigue. Contrary to the design situation for vessels and piping, no guidance in the form of a code or standard exists for vessel internals and long-life external components, especially for service in corrosive-erosive environments at elevated temperatures. Designers currently rely on their stress-analysis techniques and rules and use their experience with petrochemical applications to incorporate the environmental effects in the design of components for coal conversion systems. Such an approach may lead to adequate design, but a substantial data base is needed on the mechanical properties of materials exposed to complex gas environments to provide a more viable basis for establishing long-term reliability of components. The purpose of the present work is to examine the high-temperature creep behavior of Alloy 800, a high-chromium alloy that is widely used in coal conversion systems, after exposure to oxygen and oxygen/sulfur mixed-gas environments. The data on the creep behavior of the alloy under various pretreatment and test-exposure conditions are used to establish performance enveloped for the alloy for service in fossil energy applications.

6207 (ORNL/FMP–94/1, pp. 343-354) **Fundamental study of aluminizing and chromizing process.** He, N. (Ohio State Univ., Columbus, OH (United States)); Wang, G.; Rapp, R.A. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

For a halide-activated pack cementation process, codeposition of Cr and Si into diffusion coatings on steel surfaces can be achieved by using two halide salts to jointly optimize the partial pressures of $CrCl_2(v)$ and $SiF_2(v)$. The selection of the second salt is the key point for this process. A SOLGASMIX program was used to calculate the equilibrium vapor pressures of different metal halide gas species for different activator salt combinations. Two salts with the same cation develop low partial pressures for $CrCl_2(v)$ and $SiF_2(v)$, which are not high enough to codeposit Cr and Si into a coating. Two salts with different cations produce a different result. Some combinations, such as NaCl and CaF_2, have high and comparable partial pressures of $CrCl_2(v)$ and $SiF_2(v)$. However, other combinations either have low partial pressures, or the partial pressures of $CrCl_2(v)$ and $SiF_2(v)$ are not of the same magnitude. The role of the partial pressure for the alkali metal is elucidated. Experimental verifications are consistent with the theoretical predictions, and

thus coated steels exhibit excellent corrosion resistance to cyclic oxidation and aqueous corrosion.

6208 (ORNL/FMP–94/1, pp. 355-363) **Development of a modified 310 stainless steel.** Swindeman, R.W. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Structural materials performance requirements were re-evaluated for use in emerging fossil energy applications. Concepts included low emission boilers, advanced steam cycle, and combined-cycle technologies. Both pressure-bearing and non-pressure-bearing applications were considered. The adequacies of martensitic and austenitic steels were examined, and comparisons of the potential of various alloy selections were undertaken. Both austenitic and martensitic steels were judged to have applicability for boilers operating at 600°C while fine-grained austenitic alloys were judged to be best for service to 650°C. For applications in the range 650 to 760°C, modified 310 stainless steels were judged to be good choices. Above 760°C, the alloys being considered for pressurized fluidized bed combustors (PFBCs) included oxidation-resistant stainless steels. For carbonizers and gasifiers operating below 900°C, cobalt-bearing alloys and modified 310 stainless steels were of interest. Iron-aluminide cladding was also considered, and experimental studies were begun to examine compatibility with pressure boundary materials. The data base for modified 310 stainless steels was expanded to 1038°C, and testing times ranged to beyond 10,000 h. The performance of weldments in modified 310 stainless steel was examined and found to be adequate to enable the use of the material at 871°C. Exploratory work on fatigue was undertaken. For service above 900°C, exploratory evaluations of cast high alloys (HP) and alloy 160 were begun. Creep, fatigue and crack growth testing was initiated on alloy 160. Interactions and collaboration with industry were maintained.

6209 (ORNL/FMP–94/1, pp. 365-375) **Investigation on the weldability of high temperature alloy tubing materials.** Lundin, C.D. (Univ. of Tennessee, Knoxville, TN (United States)); Qiao, C.Y.P. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Gleeble hot ductility, Varestraint hot cracking and Finger hot cracking evaluations on thick wall commercial 310HCbN tubing material agree with and verify the weldability predictions based on the Varestraint testing results from thin wall 310HCbN materials. A good correlation was found between hot cracking and hot ductility testing results. Short term stress rupture testing of modified 800H, NF709, NF616 and transition joints between modified 800H and T91 was conducted. For welded modified 800H (with HD556 and Inconel 117 filler), the HAZ exhibits a lower rupture strength as compared to the base metal or filler metal. For welded NF709 (with 709 filler), the weld metal shows a slightly lower rupture strength compared to the HAZ and base metal. In general, the NF709 weldment (with NF709 filler) showed an equivalent or slightly lower rupture strength compared to the modified 800H weldments (with ether HD556 or Inconel 117 filler). A preliminary evaluation on iron aluminide clad stainless steel tubing was carried out. Arc spray, GTAW and GMAW techniques were utilized for preparing the clad coupons. Comparison of the characteristics of the interface in terms of the different fabrication techniques was addressed. Iron aluminide weld deposited clad on stainless steel, by fusion welding, provides for an excellent bond between the iron aluminide and stainless steel and shows relatively good operational ease.

6210 (ORNL/FMP–94/1, pp. 377-390) **Cr_2Nb-based alloy development.** Liu, C.T. (Oak Ridge National Lab., TN (United States)); Horton, J.A.; Carmichael, C.A. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

This paper summarizes recent progress in developing Cr_2Nb/Cr(Nb) alloys for structural use in advanced fossil energy conversion systems. Alloy additions were added to control the microstructure and mechanical properties. Two beneficial elements have been identified among all alloying additions added to the alloys. One element is effective in refining the coarse eutectic structure and thus substantially improves the compressive strength and ductility of the alloys. The other element enhances oxidation resistance without sacrificing the ductility. The tensile properties are sensitive to cast defects, which can not be effectively reduced by HIPping at 1450-1580°C and/or directionally solidifying via a floating zone remelting method.

6211 (ORNL/FMP–94/1, pp. 391-400) **Alloying effects on the high-temperature oxidation resistance of Cr-Cr_2Nb.** Tortorelli, P.F. (Oak Ridge National Lab., TN (United States)); DeVan, J.H. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Alloying effects on the high-temperature oxidation resistance of Cr-Cr_2Nb were examined on the basis of isothermal exposures to air at 950°C. Additions of either Re and Al or Fe, Ni, and Al had relatively little effect on weight gains relative to the Cr-6% Nb binary alloy. One alloying element that improved the mechanical behavior of Cr-Cr_2Nb alloys substantially increased the oxidation rates and spallation susceptibilities of Cr -6 and -12% Nb alloys. However, the addition of another element completely offset these deleterious effects. The presence of this latter element resulted in the best overall oxidation behavior (in terms of both weight gains and spallation tendencies) of all Cr-Cr_2Nb compositions. Its beneficial effect can be attributed to improvement in the oxidation resistance of the Cr-rich phase.

6212 (ORNL/FMP–94/1, pp. 401-412) **Fracture behavior of Cr_2Nb-based intermetallics.** Cook, J.A. (Univ. of Tennessee, Knoxville, TN (United States)); Liaw, P.K.; Liu, C.T. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Microstructural evaluations of Laves-phase alloys based on Cr_2Nb were examined in order to determine phase relationships with heat treating temperatures up to 1580°C. At ambient temperatures, single-phase Cr_2Nb alloys are very hard and brittle due to the difficulty in generation and glide of dislocations because of the complicated crystal structure (C-15). The following results were revealed through examination of the Cr-Cr_2Nb two-phase region: (a) with increasing amounts of the soft chromium-rich phase, the hardness decreases; (b) the heat treatments studied provided the best dispersion of the chromium-rich phase in the Cr-6at.% Nb (CN-7) alloy; (c) an anneal of 3 days at 1100°C + 1 hour at 1580°C provided for the best dispersion of the Cr-rich phase and break-up of the Laves-type phase in the CN-7 alloy. Previous studies have shown that the introduction of a soft chromium phase has promising effects in improving the mechanical properties of brittle Cr_2Nb Laves-phase alloys.

6213 (UCRL-ID–112775, pp. 6.23-6.30) **Modeling superplastic materials.** Lesuer, D.R.; Syn, C.K.; Preuss, C.S.; Raboin, P.J. Lawrence Livermore National Lab., CA (United States). Mar 1993. In *Materials Science and Engineering.* 30p. Order Number DE94003018. Source: OSTI; NTIS; GPO Dep.

In this work, the authors have developed a model that accounts for grain growth during superplastic flow, and its subsequent influence on stress/strain/strain rate behavior. The studies are experimentally based and have involved two different types of superplastic materials: a quasi-single phase metal, Coronze 638, and a microduplex metal, ultrahigh-carbon steel. The kinetics have been studied of strain-enhanced grain growth in both materials as a function of strain, strain rate, and temperature. An equation for

the rate of grain growth has been developed that incorporates the influence of temperature. The model integrates grain growth laws derived from these studies, with two mechanism-based, rate-dependent constitutive laws to predict the stress/strain/strain rate behavior of materials during superplastic deformation. The material model has been added to the NIKE2D code through an enhancement of the Deformation Mechanism Model. The predictions of the model have been compared with data from several experiments. 11 refs., 10 figs., 2 tabs.

6214 (UCRL-ID–112775, pp. 6.7-6.9) **Casting process modeling.** Shapiro, A.B. Lawrence Livermore National Lab., CA (United States). Mar 1993. In *Materials Science and Engineering.* 30p. Order Number DE94003018. Source: OSTI; NTIS; GPO Dep.

In predicting the quality of a cast part, two important factors are (1) correct modeling of the fluid flow and heat transfer during the filling of a mold with a molten metal, and (2) the thermal-mechanic physics of solidification and cool-down. Determining the dynamics of the flow and the free surface shape during filling are essential in establishing the temperature gradients in the melt and in the mold. Correctly modeling the physics of volume change on solidification, shrinkage on cooling, and contact resistance across the part-mold interface directly affects the cooling rate and, ultimately, the final cast shape and stress state of the cast part. This year's efforts were focused on modeling fluid fill and on the physics of solidification. 3 refs., 2 figs.

6215 (VTT-PUB–131) **Computer-aided simulation of the heat treatment.** Arola, R. (Technical Research Centre of Finland, Espoo (Finland). Metallurgy Lab.); Martikainen, H.; Virta, J. Technical Research Centre of Finland, Espoo (Finland). 1993. 49p. Order Number DE95723867. Source: OSTI; NTIS.

Computer-aided simulation of the heat treatment of components and charges is examined. Existing programs for the simulation of heat treatment are reviewed. Test simulations including calculation of temperature, phase composition and stresses and strains during heating and cooling are performed with selected programs. The results of the simulations are compared with the results of heat treating experiments. Heat transfer during heating-up varies considerably between different treatments, components of the charge and surfaces of the component. Therefore, heat transfer data defined on the basis of the measurements has to be used in exact simulation instead of literature data. According to the simulation results non-uniform temperature distribution, plastic straining and residual stresses after heating can be formed in an AISI 316 bar heated up at the edge of a charge in a pit furnace. Permanent bending of these bars as a result of heating is not observed. In the oil quenching of a 42CrMo4 cylinder, where martensite and bainite are formed in austenite decomposition, the simulation results (especially amounts of phases and residual stresses) are crucially dependent on the TTT-diagram describing the kinetics of the phase transformations. Several TTT-diagrams for the steel grade are found, leading to different simulation results.

6216 (WSRC-MS–94-0535) **MIC damage in a water coolant header for remote process equipment.** Jenkins, C.F. Westinghouse Savannah River Co., Aiken, SC (United States). 27 Sep 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-950304–2: National Association of Corrosion Engineers corrosion conference, Orlando, FL (United States), 20-25 Mar 1995). Order Number DE95002693. Source: OSTI; NTIS; INIS; GPO Dep.

Stainless steel water piping used to supply coolant for remote chemical separations equipment developed leaks during low flow conditions resulting from an extended interruption of operations. All the leaks occurred at welds in the bottom zone of the pipe, which was blanketed with silt deposits from the unfiltered well water used for cooling. Ultrasonic, radiographic, and metallographic examinations of leak sites revealed worm hole pitting adjacent to the welds. Seepage at the penetrations was strongly acidic and resulted in corrosion on the external pipe surfaces beneath brown crusty deposits which had developed. Analyses of the water and deposits suggest a strong propensity toward microbiologically influenced corrosion (MIC) and fouling.

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Refer also to citation(s) 4908, 4983, 5652, 5662, 5663, 5671, 5672, 5673, 5674, 5675, 5867, 5964, 6079, 6085, 6086, 6245, 6861, 6893

6217 (BNL–60962) **Some aspects of critical currents in Ag sheathed $Bi_2Sr_2Ca_2Cu_3O_{10}$ composite tapes: A summary.** Suenaga, M. (Brookhaven National Lab., Upton, NY (United States)); Li, Qiang; Fukumoto, Y.; Shibutani, K.; Wang, Y.L.; Wiesmann, H.J.; Haldar, P.; Motowidlo, L. Brookhaven National Lab., Upton, NY (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-941014–1: Topical conference on the critical state in superconductors, Honolulu, HI (United States), 24-26 Oct 1994). Order Number DE95003952. Source: OSTI; NTIS; INIS; GPO Dep.

Detailed and high sensitivity ($E \geq 10^{-9}$ V/cm) measurements of J-E (I-V) characteristics were made for $Bi_2Sr_2Ca_2Cu_3O_{10}$/Ag composite tapes at 4.2, 2.7, 55-90, and 64-77 K in liquid cryogens and at H = 0-17 T. The results have helped clarify the critical current limiting factors as well as revealing a new low voltage dissipation phenomena in these composites. A brief summary of the results are presented.

6218 (CIEMAT–735) **Dielectric properties measurement system at cryogenic temperatures and microwave frequencies.** Molla, J.; Ibarra, A.; Margineda, J.; Zamarro, J.M.; Hernandez, A. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 17p. Order Number DE95721644. Source: OSTI; NTIS; INIS.

A system based on the resonant cavity method has been developed to measure the permittivity and loss tangent at 12-18 GHz over the temperature range 80 K to 300 K. Changes of permittivity as low as 0.01% in the range 1 to 30, and 3 x 10^6 for loss tangent values below 10^2, can be obtained without requiring temperature stability. The thermal expansion coefficient and resistivity factor of copper have been measured between 80 K and 300 K. Permittivity of sapphire and loss tangent of alumina of 99,9% purity in the same temperature range are presented.

6219 (CIEMAT–736) **Dielectric properties of alumina/zirconia composites at millimeter wavelengths.** Molla, J.; Heidinger, R.; Ibarra, A.; Link, G. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 16p. Order Number DE95721645. Source: OSTI; NTIS; INIS.

Alumina-zirconia composites with ZrO_2 contents up to 20% and negligible porosity were investigated at millimeter (mm) wavelengths to determine the changes appearing in the dielectric properties of pure alumina ceramics when unstabilized or partially stabilized ZrO_2 is added to improve the mechanical strength. It is demonstrated that it essential to distinguish between the contributions of the monoclinic and the tetragonal phase of zirconia (m-ZrO_2, t-ZrO_2). Permittivity is raised with increasing content of either phases; the effective permittivity can be assessed by the rule of mixtures (Maxwell-Garnett formulation of the generalized Clasussius-Mossotti relation) using permittivity values of 10 for Al_2O_3, 14-21 for m-ZrO_2 and 40-45 for t-ZrO_2. The permittivity data show only a small variation in the investigated range of 9-145 GHz. For the dielectric loss, there is evidence of a predominant contribution of m-ZrO_2; in addition, the marked increase in loss with frequency becomes sharper. The t-ZrO_2, which is responsible for strengthening, does not show any significant influence on losses. It is therefore concluded, that ZrO_2 strengthening of alumina is feasible without affecting mm-wave losses at room temperature as long as the presence of m-ZrO_2 is avoided.

6220 (ETDE/DE-mf–95726997) **Electrical properties of pure and TiO_2-doped tetragonal ZrO_2.** Kopp, A. Stuttgart Univ. (Germany). Fakultaet 3 - Chemie. 2 Nov 1992. 99p. (In German). Order Number DE95726997. Source: OSTI; NTIS (US Sales Only).

The ionic and electronic properties of undoped and TiO_2-doped tetragonal ZrO_2 were investigated. Electric conductivities were measured using impedance spectroscopy and the steady-state polarisation method according to Hebb and Wagner. The diffusion coefficients of the electronic charge carriers were derived from

transient-state polarisation measurements. The composition, the temperature, and the oxygen partial pressure of the ambient atmosphere were used as variables. (orig.)

6221 (ETDE/DE-mf–95733399) **The strength of brittle materials in the light of probabilistics.** Esslinger, P. MTU Motoren- und Turbinen-Union Muenchen GmbH (Germany). 10 Sep 1990. 30p. (In German). Order Number DE95733399. Source: OSTI; NTIS (US Sales Only).

An integral equation is derived for the fracture probability of structural ceramics (and of brittle materials in general). It contains a Weibull relationship as a special case. This results in a physical interpretation of the adaptation parameters of the Weibull relationship (m, V_0, σ_0). It also shows the points where material development should start in order to improve reliability. The influence of the surface area is quantified for tensile and bending test pieces. (orig./MM). 6 figs.

6222 (ETDE/JP-mf–95730104) **Study of composite zirconium oxide.** National Inst. for Research in Inorganic Materials, Tsukuba (Japan). 25 Nov 1993. 56p. (In Japanese). Order Number DE95730104. Source: OSTI; NTIS; Available from National Institute for Research in Inorganic Materials, 1-1, Namiki, Tsukuba, Ibaraki, Japan.

This paper is a collection of research reports of 1993 regarding inorganic materials published by Japan Science and Technology Agency. The research subject is ZrO2-MOx. The principal component of the composite oxide under research, ZrO2, is multifunctional and is widely used as a structural material. It is prospective for an optoceramics material such as PLZT or a material for intellectual functions. Unlike the existing techniques, excellent ceramics materials for fundamental study are produced and characterized by using a technique for synthesizing, characteristic composition, or nature (functions and properties). To summarize, the study include the wet adjusting method of raw powder material, uniform melting method of impurities such as SiO2 and CaO, effects of Mn ion on diffusion coefficient and piezo-electric characteristic of PLZT ceramics, sintering structure of easily sinterable Mg powder, effective partial pressure of oxygen at HIP, multistep wet synthesis of SrZrO3, destructive observation and 500°C fatigue cracking of ZrO2, intelligent intellectual elements, heat transfer degradation in fine area, and self-return. As a result of these researches, about 90 reports were presented on the paper and 56 patents were applied in Japan and 4 in other countries. 63 refs., 84 figs., 1 tab.

6223 (ETDE/JP-mf–95730106) **Study of copper perovskite.** National Inst. for Research in Inorganic Materials, Tsukuba (Japan). 25 Nov 1993. 68p. (In Japanese). Order Number DE95730106. Source: OSTI; NTIS; Available from National Institute for Research in Inorganic Materials, 1-1, Namiki, Tsukuba, Ibaraki, Japan.

This paper describes the research reports of 1993 regarding Cu Perovskite SC (Superconductor) published by Japan Science and Technology Agency. This is the study of superconductivity at a high critical temperature (Tc = 30 K or more) of copper-containing K2NiF4 type oxide. The study includes synthesis, characterization, and examination of substantial nature of this superconductor. Synthesis was conducted by applying the very fast cooling thick film synthesis method and some other methods. Characterization was achieved by observing the newly designed SXDM/XPD. The substantial nature was verified by using the Meissner effect measurement method. Amorphous film of Bi series oxide SC was created by applying the very fast cooling method for the first time in the world. Bi-Pb thick film was created, and high-orientation film was produced on the trial basis. The complete C-axis orientation film of (Nd - Ce) $_2$CuO4 could be produced on the trial basis by using the sputtering method. Copper-containing oxide was synthesized at a high oxygen pressure, and the substantial nature of magnetic oxide was examined at a high pressure. The quality of lead germanate could also be improved by using the very fast cooling method. Each study subject is partially successful through the newly proposed techniques, but many issues to be corrected are still in the most part of each study. 108 refs., 127 figs., 8 tabs.

6224 (LA-UR–94-1390) **Transport properties of $Tl_2Ba_2CaCu_2O_8$ meander lines.** Fleshler, S.; Maley, M.P.; Jia, Quanxi; Wu, Xin Di; Lacerda, A. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941013–13: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95003715. Source: OSTI; NTIS; GPO Dep.

The authors have measured the electrical transport properties of 10 cm long $Tl_2Ba_2CaCu_2O_8$ thin film meander lines in magnetic fields up to 18T. The large resistance of the meander line effectively increased the electric field, or equivalently, resistivity sensitivity by two orders of magnitude. In moderate magnetic fields the critical current density is found to depend only on the component of the magnetic field normal to the ab planes owing to the highly anisotropic nature of the system. The resistivity versus temperature was measured as a function of magnetic field up to 18T. The linear resistivity is found to vanish in a manner consistent with the occurrence of a second order phase transition. The critical exponent v(z-1) is virtually field independent with a value 5.3 $\pm$1 consistent with previous measurements of a three dimensional vortex glass transition in $YBa_2Cu_3O_7$ and $Bi_2Sr_2CaCu_2O_8$. The critical regime is 10-15K wide in agreement with values for $Bi_2Sr_2CaCu_2O_8$ at high magnetic field.

6225 (LA-UR–94-3789) **Preparation of high quality $YBa_2Cu_3O_{7-\delta}$ thick films on flexible Ni-based alloy substrates with textured buffer layers.** Wu, X.D. (and others); Foltyn, S.R.; Arendt, P.; Townsend, J.; Campbell, I.H.; Tiwari, P.; Jia, W.X.; Willis, J.O.; Maley, M.P.; Coulter, J.Y. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941013–1: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95003686. Source: OSTI; NTIS; GPO Dep.

High current $YBa_2Cu_3O_{7-\delta}$ (YBCO) thick films on flexible nickel substrates with textured buffer layers were deposited by using ion beam assisted deposition (IBAD). Pulsed laser deposited YBCO films were not only c-axis oriented with respect to the film surface but also strongly in-plane textured. The in-plane mosaic spread of YBCO films was $\sim 10°$. A critical current density of $8x10^5$ A/cm^2 was obtained at 75 K and zero field for thin YBCO films. It was also demonstrated that thick YBCO films with a high critical current and excellent magnetic field dependence at liquid nitrogen temperature can be obtained on flexible nickel substrates by using the textured buffer layers. Issues encountered in producing the films were discussed.

6226 (LA-UR–94-3850) **Effect on C-axis transport properties of a critical state in $Bi_2Sr_2CaCu_2O_8$.** Cho, J.H.; Maley, M.P.; Bulaevskii, L.N. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941013–12: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95003695. Source: OSTI; NTIS; GPO Dep.

At low temperatures, the c-axis transport properties of $Bi_2Sr_2CaCu_2O_8$ single crystals depend strongly on the magnetic field history for fields applied along the c-axis, indicating the effect of a critical state in the ab direction. In this study, the authors report zero field cooled (ZFC), field cooled warming (FCW), and field cooled cooling (FCC) c-axis transport properties. In addition, they also report magnetic relaxation measurements on the same samples to identify the c-axis dissipation mechanism. They observe a relaxation of the c-axis resistivity that follows the relaxation of the flux profile across the ab plane. By identifying the irreversible temperature vs. magnetic field for H //c, they construct a phase diagram of vortex states. Finally, they will discuss the implication of the phase diagram and the features related to the transport properties of the Josephson-coupled system and the role of pancake vortices in highly two-dimensional superconductors.

6227 (LA-UR–94-3930) **Electrochemical studies of perovskite mixed conductors.** Brosha, E.L. (Los Alamos National Lab., NM (United States). Electronic and Electrochemical Materials and Devices Group); Chung, B.W.; Garzon, F.H. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–15: 1994 fall meeting of the Materials Research

Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003704. Source: OSTI; NTIS; GPO Dep.

Research into the growth of high-quality single crystal thin films of high transition temperature T_c superconductors have stimulated interest in other perovskite metal oxides with a variety of physical properties. Thin films of perovskite materials are among the major focal research areas for optical, sensor, electronic, and superconducting applications. Two lanthanum-based oxygen/electronic conducting perovskite oxides of particular interest for high temperature fuel cell electrodes and interconnects and for other electrochemical applications such as oxygen separation devices are $La_{1-x}Sr_xMnO_{3-y}$ and $La_{1-x}Sr_xCoO_{3-y}$. The La-based perovskites are valuable for these technologies because they reduce interfacial resistances by eliminating the need for a three phase contact area (gas, metal electrode, electrolyte). In addition, these oxides may also serve a valuable role as novel catalysts or catalytic supports; however, little is known about what catalytic properties they may possess. Fundamental study of the electrochemical, diffusional oxygen transport, and surface catalytic properties of these materials can be greatly simplified if the complications associated with the presence of grain boundaries and multiple crystallite orientations can be avoided. Therefore, single crystals of these La-based perovskites become highly desirable. In this work, the authors report the structural and electrical properties of highly oriented thin films of $La_{0.84}Sr_{0.16}MnO_3$ and $La_{0.8}Sr_{0.2}CoO_3$ grown on single crystal Y-ZrO_2 substrates. An addition, the authors have demonstrated growing, in situ, epitaxial multilayer perovskite/fluorite/perovskite configurations for fundamental fuel cell modeling.

6228 (LA-UR–94-3935) **Vapor deposition of thin-film Y-doped ZrO_2 for electrochemical device applications.** Chung, B.W.; Brosha, E.L.; Brown, D.R.; Garzon, F.H. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–13: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003705. Source: OSTI; NTIS; GPO Dep.

Solid oxide electrolytes based on yttria-stabilized zirconia (YSZ) are widely used in applications such as oxygen sensors, solid oxide fuel cells, oxygen pumps, electrocatalytic reactors, and electrochemically driven oxygen separation membranes. However, bulk YSZ is used in these applications. This requires high operating temperatures in order to minimize ohmic loss. One alternative of overcoming this problem is to use a thin film of the electrolyte. In the work, the authors have grown polycrystalline thin films of fully stabilized Y-ZrO_2 on thick porous Al_2O_3 substrates in multilayer $La_{1-x}Sr_xMEO_3$YSZ/$La_{1-x}Sr_xMEO_3$ (ME = Mn, Co) configurations using a combination of single-target RF magnetron sputtering and electron beam physical vapor deposition techniques. The structure and morphology of these films have been studied using X-ray diffraction, and Scanning Electron Microscopy techniques. The ionic conductivity of the thin films has been measured using AC impedance analysis.

6229 (LA-UR–94-3966) **Thin film ionic conductors based on cerium oxide.** Haridoss, P. (Univ. of Wisconsin, Madison, WI (United States)); Hellstrom, E.; Garzon, F.H.; Brown, D.R.; Hawley, M. Los Alamos National Lab., NM (United States). [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–9: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003668. Source: OSTI; NTIS; INIS; GPO Dep.

Fluorite and perovskite structure cerium oxide based ceramics are a class of materials that may exhibit good oxygen ion and/or protonic conductivity. The authors have successfully deposited thin films of these materials on a variety of substrates. Interesting orientation relationships were noticed between cerium oxide films and strontium titanate bi-crystal substrates. Near lattice site coincidence theory has been used to study these relationships.

6230 (LA-UR–94-4052) **Orientation selection and microstructural evolution of epitaxial platinum films on (001) magnesium oxide.** McIntyre, P.C.; Maggiore, C.J.; Natasi, M. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–3: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003680. Source: OSTI; NTIS; GPO Dep.

Thin platinum films were deposited at several different deposition rates and with varying thickness on (001)-cut MgO single crystal substrates by electron beam evaporation. A mixture of two epitaxial Pt orientations were detected in the films by X-ray diffraction and planar ion channeling experiments: (001)[100]Pt //(001)[100]MgO (the "cube-on-cube" orientation) and (111)[110]Pt //(001)[110]MgO. The effect of deposition rate on film orientation indicated the (111)Pt orientation was preferred under conditions of high driving force for nucleation. The volume fraction of the films occupied by the (111) orientation increased with nominal film thickness, at a constant substrate temperature and deposition rate. This result indicates crystallites having the (111)Pt orientation grew more quickly following nucleation than the (001). The mosaic spread of the Pt orientation decreased markedly as the nominal film thickness increased from ~ 1.5 nm (isolated islands) to 20 nm (continuous film).

6231 (LBL–36149) **Ion-assisted laser deposition of intermediate layers for $YBa_2Cu_3O_{7-\delta}$ thin film growth on polycrystalline and amorphous substrates.** Reade, R.P. Lawrence Berkeley Lab., CA (United States). Nov 1993. 117p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95003507. Source: OSTI; NTIS; GPO Dep.

The growth of $YBa_2Cu_3O_{7-\delta}$ (YBCO) high-temperature superconductor thin films has largely been limited to deposition on single-crystal substrates to date. In order to expand the range of potential applications, growth on polycrystalline and amorphous substrates is desirable. In particular, the deposition of YBCO thin films with high critical current densities on polycrystalline metal alloys would allow the manufacture of superconducting tapes. However, it is shown that it is not possible to grow YBCO thin films directly on this type of substrate due to chemical and structural incompatibility. This work investigates the use of a yttria-stabilized zirconia (YSZ) intermediate layer to address this problem. An ion-assisted pulsed-laser deposition process is developed to provide control of orientation during the growth of the YSZ layers. The important properties of YBCO and YSZ are summarized and the status of research on thin film growth of these materials is reviewed. An overview of the pulsed-laser deposition (PLD) technique is presented. The use of ion-assisted deposition techniques to control thin film properties is discussed.

6232 (LNS–174) **Neutron scattering investigations into high-temperature superconductors.** Guillaume, M. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Eidgenoessische Technische Hochschule, Zurich (Switzerland). Lab. fuer Neutronenstreuung. Oct 1994. 137p. (In German). Order Number DE95610881. Source: OSTI; NTIS; INIS.

Dissertation ETH-Zurich.

The perovskite-type high-T_c compounds $RBa_2Cu_3O_x$ (R=Y, most rare earths, except Ce and Tb) does not exhibit superconductivity. Until today there is no generally accepted explanation for the unusual behaviour of the Pr system. The suppression of superconductivity in the $RBa_2Cu_3O_7$ compound is related to an electronic change which should also influence the structural parameters. To check this assumption, a systematic low temperature neutron-diffraction study was made of the $RBa_2Cu_3O_x$ (R=Y and rare earth; x=7 and 6.1) compounds. Comparison of various interatomic distances in function of the radius of the trivalent rare earths exhibit the well known lanthanide contraction with the exception of the bond lengths of Pr-O(2), Cu(2)-Cu(2) and Cu(2)-O(3) in $PrBa_2Cu_3O_7$ which are much shorter compared to the other lanthanide compounds. This shortening of the bond lengths must be related to suppression of superconductivity in $PrBa_2Cu_3O_7$. This tendency was also observed for the $Er_{1-y}Pr_yBa_2Cu_3O_x$ system. Furthermore structure analyses show a critical buckling angle in the CuO_2 planes: if the buckling is larger than a critical value of 167.3°, superconductivity is destroyed. In fast neutron irradiated $ErBa_2Cu_3O_7$ samples (this treatment decreases T_c) we also observed a tendency towards this critical value. Indeed, for

$PrBa_2Cu_3O_7$ we found the buckling angle to be above the critical value. By means of inelastic neutron scattering we were able to show that the superconductivity in the mixed $Er_{1-y}Pr_yBa_2Cu_3O_x$ system is only locally destroyed by the Pr ions, and their influence on the crystalline electric field at the Er site can be explained by a small structural distortion. (author) figs., tabs., refs.

6233 (ORNL/FMP–94/1, pp. 99-104) **Modeling of fibrous preforms for CVI fabrication.** Starr, T.L. (Georgia Institute of Technology, Atlanta, GA (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

We describe our ongoing efforts toward modeling the chemical vapor infiltration (CVI) of tube shapes, in support of experimental process development at Oak Ridge National Laboratory (ORNL). Model modifications needed to match the ORNL reactor include adding radiant heat transfer and adjusting heat transport conditions at the tube ends. Model densification times are in good agreement with experiment. For this preform geometry higher gas flow rate and MTS concentration are needed for rapid densification. Higher furnace temperature can be used at these higher gas flow rates and as the tube densifies. A strategy for optimized processing may involve continuous variation of furnace temperature and control of gas flow rate for efficient utilization of MTS.

6234 (ORNL/FMP–94/1, pp. 105-116) **Development of oxidation-resistant interface coatings.** Lowden, R.A. (Oak Ridge National Lab., TN (United States)); Schwarz, O.J.; Stinton, D.P. Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Porous silicon carbide (SiC) was examined as an interlayer to improve the elevated-temperature stability of Nicalon/SiC composites. Porous SiC coatings were deposited on fibrous preforms from gas mixtures containing methylsilane (CH_3SiH_3), methane (CH_4), argon, and hydrogen. The effects of the carbon to silicon ratio and the concentration of hydrogen in the gas mixture, on the microstructure and composition of the SiC interlayer were examined. The coated preforms were densified with a silicon carbide matrix using the forced-flow, thermal-gradient chemical vapor infiltration (FCVI) process. Room-temperature flexure strengths of as-fabricated composites and specimens exposed to 1273 K in air for 24 h, were measured to assess the effectiveness of the interlayer. Layer thickness, microstructure, and composition influenced as-fabricated and post-exposure properties. Materials fabricated with a variety of porous SiC coatings showed improvements in retained strength as compared to those with traditional carbon coatings.

6235 (ORNL/FMP–94/1, pp. 117-124) **Joining of SiC ceramics and SiC/SiC composites.** Rabin, B.H. (Idaho National Engineering Laboratory, Idaho Falls, ID (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Reaction processing methods have been developed and employed to produce SiC-to-SiC joints for use in elevated temperature fossil energy applications. The strength and fracture toughness of joints were characterized and found to be comparable to commercial bulk reaction bonded silicon carbide (RBSC), making these joints potentially useful for service temperatures exceeding 1000°C. Recent efforts have focused on constructing and testing a localized induction heating apparatus for fabricating tube-to-tube joints. It has been demonstrated that microstructurally sound tube-to-tube joints can be produced; further research is needed to evaluate the properties of joined tubular components, and to scale up the process to allow larger diameter and longer length tubes to be handled. Technology transfer activities involving industry are discussed.

6236 (ORNL/FMP–94/1, pp. 125-136) **Densification of nano-size powders.** Chen, W. (National Institute of Standards and Technology, Bethesda, MD (United States)); Malghan, S.G.; Dapkunas, S.J.; Piermarini, G.; Danforth, S.C. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Green compacts from a nano-size silicon nitride powder were fabricated having density up to 67% of theoretical at 2.8 GPa pressure using liquid nitrogen and pentane as compaction lubricant media. Pressureless sintering of these transparent samples did not promote further densification beyond that obtained for the green state. To further increase the density of these samples, a hot-pressing device was designed. In a series of experiments, hot-pressing of these samples at 0.5 to 1.0 GPa and 800°C, followed by pressureless sintering at 1400°C was studied. The resulting silicon nitride ceramic had a Vickers hardness of 9.0 GPa while transparency under visible light was maintained. Without the use of hot pressing, the hardness obtained was 5.8 GPa. In addition, the effect of compaction pressure on densification was studied for nano-size Al_2O_3 to further understand factors contributing to achieving high green densities. The dense Al_2O_3 green samples were pressureless sintered to near full density at temperatures several hundred degrees lower than those needed for sintering low density green material.

6237 (ORNL/FMP–94/1, pp. 163-168) **Microwave-assisted chemical vapor deposition.** Janney, M.A. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The purpose of this research is to explore the feasibility of using microwave heating to enhance the chemical vapor infiltration (CVI) process developed under FEMP sponsorship. The goal is to achieve faster deposition rates, greater control over deposition conditions and resulting microstructures, and perhaps lower temperature infiltration.

6238 (ORNL/TM–12778) **Ceramic Technology Project, semiannual progress report for October 1993 through March 1994.** Johnson, D.R. Oak Ridge National Lab., TN (United States). Sep 1994. 456p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003394. Source: OSTI; NTIS; GPO Dep.

The Ceramic Technology Project was originally developed by the Department of Energy's Office of Transportation Systems (OTS) in Conservation and Renewable Energy. Significant accomplishments in fabricating ceramic components for the Department of Energy (DOE), National Aeronautics and Space Administration (NASA), and Department of Defense (DoD) advanced heat engine programs have provided evidence that the operation of ceramic parts in high-temperature engine environments is feasible. An assessment of needs was completed, and a five-year project plan was developed with extensive input from private industry. In July 1990, the original plan was updated through the estimated completion of development in 1993. The original objective of the project was to develop the industrial technology base required for reliable ceramics for application in advanced automotive heat engines. During the course of the Ceramic Technology Project, remarkable progress has been made in the development of reliable structural ceramics. The direction of the Ceramic Technology Project is now shifting toward reducing the cost of ceramics to facilitate commercial introduction of ceramic components for near-term engine applications. In response to extensive input from industry, the plan is to extend the engine types which were previously supported (advanced gas turbine and low-heat-rejection diesel engines) to include near-term (5-10 years) applications in conventional automobile and diesel truck engines. To facilitate the rapid transfer of this technology to U.S. industry, the major portion of the work is being done in the

ceramic industry, with technological support from government laboratories, other industrial laboratories, and universities. A systematic approach to reducing the cost of components is envisioned.

6239 (SAND–94-8415C) **Transport in chemical vapor deposition reactors: A two-dimensional model including multicomponent and thermal diffusion, and species interdiffusion.** Evans, G. (Sandia National Labs., Livermore, CA (United States)); Greif, R. Sandia National Labs., Livermore, CA (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract AC04-76DP00789. Contract F33615-89-C-5628. (CONF-950336–5: American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference, Maui, HI (United States), 19-24 Mar 1995). Order Number DE95002484. Source: OSTI; NTIS; GPO Dep.

The chemical vapor deposition (CVD) process that consists of depositing coatings of silicon nitride from silicon tetrafluoride and ammonia at low-pressure is modeled in a reactor simulation. Combined effects of surface chemical kinetics, multicomponent diffusion, convection, thermal diffusion, species interdiffusion, and variable properties are included in a reactor model. Full multicomponent diffusion is included by solving the StefanMaxwell equations. Species interdiffusion and thermal diffusion are included in the energy and species conservation equations. Results are for five gas phase species with two surface reactions specified for the deposition. Distributions of radial and axial components of velocity, species, temperature, and deposition rate and deposition profile are obtained in a tube reactor. Effects of the combined transport mechanisms noted above are determined. The decomposition of NH_3 into N_2 and $H2_2$ retards deposition of silicon nitride and dilutes the incoming reactants. This dilution is strongly enhanced by thermal diffusion since the direction of the temperature gradient causes the light species generated by the surface reactions to remain near the surface resulting in smaller and nonmonotonic deposition rates. The effects of a ramp in the surface temperature on the deposition rate and profile and on the transport processes are also determined.

3606 Other Materials

Refer also to citation(s) 4910, 5119, 5166, 5212, 5261, 5878, 6012, 6084, 6099, 6274, 6286, 6293, 6353, 7054

6240 (ANL/MSD/CP–84837) **Rotor phases in compound semiconductors.** Price, D.L. (Argonne National Lab., IL (United States). Materials Science Div.); Saboungi, M.L.; Howells, W.S. Argonne National Lab., IL (United States). Materials Science Div. Nov 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9410165–9: Neutron scattering, Sendai (Japan), 11-14 Oct 1994). Order Number DE95004139. Source: OSTI; NTIS; GPO Dep.

Quasi-elastic neutron scattering is used to study the disordering processes in two classes of semiconductor: I-IV Zintl compounds and the phosphorus-selenium system. Two alkali-metal-polyvalent metal Zintl compounds, CsPb and NaSn, exhibit a two-stage melting process with high-temperature solid phases characterized by rapid dynamical disorder. In CsPb this disorder is clearly associated with rapid reorientations of polyanions with the cations participating in the dynamical disorder on the same time scale. In NaSn the disorder is associated with fast reorientations of the polyanions closely coupled to a slower migration of the cations. The two high-temperature solid phases of the molecular crystal P_4Se_3 are confirmed to be rotor phases with small but significant differences in the reorientational motions in the two phases. Zintl compounds are formed from an electropositive metal A and an electronegative metal on semimetal M. Electron transfer from A to M, along with directional bonding between the M-ions, leads to chemical behavior in these ions characteristic of elements to the right of M in the periodic table.

6241 (BDX–613-531) **A study of polyether-polyol- and polyester-polyol-based rigid urethane foam systems.** Madden, J.P.; Baker, G.K.; Smith, C.H. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Sep 1971. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-710913–1: 162. national meeting of the American Chemical Society, Washington, DC (United States), 12-17 Sep 1971). Order Number DE95003899. Source: OSTI; NTIS; GPO Dep.

For the past 10 years polyurethane polymers have been one of the fastest growing segments of the plastics industry. Over 900 million pounds of polyurethanes were used in 1970. Approximately 30% of this amount was consumed in the form of rigid urethane foam products. This study undertakes a comparison of the properties of rigid urethane foams based on both a polyester polyol and polyether polyol of the same hydroxyl number prepared from alpha methylglucoside. This comparison of ester and ether polyols in urethane foams is closer than in previous studies because: (1) both types of polyols are based on alpha methylglucoside; (2) they both have the same hydroxyl number and functionality; and (3) the rigid foams in which they are used have been formulated to have essentially the same crosslink density. Several physical and thermal properties of the foam systems were determined. A discussion of test results as they relate to the presence of the ester and ether linkages in the polyols is presented.

6242 (BNL–60869) **Spin polarized photoemission studies of magnetic quantum well states.** Johnson, P.D. (Brookhaven National Lab., Upton, NY (United States). Physics Dept.). Brookhaven National Lab., Upton, NY (United States). [1994]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-940829–1: 14. international colloquium on magnetic films and surfaces, Duesseldorf (Germany), 29 Aug - 2 sep 1994). Order Number DE95004218. Source: OSTI; NTIS; GPO Dep.

There is currently considerable technological interest in the properties of transition metal multilayers. In these multilayers, which include Fe/Cr(001) and Cu/Co(001), it is possible to achieve either ferromagnetic or antiferromagnetic coupling of the adjacent ferromagnetic layers depending on the thickness of the intervening layer. The related giant magnetoresistance properties and the large enhancement of the Kerr rotation in these systems make them particularly interesting. In this paper, quantum well states with discrete binding energies dependent on the thickness of the film are observed in copper films deposited on a Co(001) substrate. They are found to be spin polarized, preferentially with minority spin. These states pass up to and through the Fermi level with a frequency identical to the long period of oscillation in the associated magnetic multilayers. In the pre-asymptotic limit the dispersion of these states away from the center of the zone is described by enhanced effective masses. This has implications for theories of the oscillatory exchange coupling that invoke the bulk Fermi surface.

6243 (BNL–60904) **Profiling and light scattering studies of Si surfaces.** Church, E.L. (Brookhaven National Lab., Upton, NY (United States)); Takacs, P.Z.; Stover, J.C. Brookhaven National Lab., Upton, NY (United States). Oct 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-950246–1: Microphysics of surfaces: nanoscale processing meeting, Santa Fe, NM (United States), 9-11 Feb 1995). Order Number DE95002931. Source: OSTI; NTIS; GPO Dep.

There is great interest in the semiconductor industry in developing light-scattering techniques for detecting "killer particles" on Si wafer surfaces. The surface power spectral density (PSD) is important since it determines the intensity and angular dependence of the background scattering; understanding it will lead to a deeper understanding of finishing processes. Scattering measurements showed that Si wafer surfaces have the radiation-wavelength and angular dependences expected for weak topographic scattering. The data and independent profile measurements were used to deduce consistent values of the surface PSDs over the wavelength range 50 nm to 1 mm. The profile PSDs were found to consist of a sum of inverse power-law components, i.e., the surfaces are fractal-like. There is an analogy between the results and spontaneous thermodynamic roughening of solid surfaces: Below the critical roughening temperature, the surface topography is determined by the underlying crystal structure, while above it, the

surface "melts" and the roughness is determined by capillary-wave excitations of the surface. Capillary waves have the well-known $1/f_x$ profile power spectrum.

6244 (DOE/CE/15974–T9) **Progress report on conductive paints, September 1, 1994–November 30, 1994.** Soukup, R.J. Ianno, N.J. Nebraska Univ., Lincoln, NE (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-92CE15974. Order Number DE95004297. Source: OSTI; NTIS; GPO Dep.

This progress report describes testing of the electric and thermal conducting properties of conductive metallic paints. The apparatus constructed for these measurements is described.

6245 (ETDE/DE-mf–95733455) **Soldering ceramics to metals. Development of solders and soldering methods. Final report.** Weise, W.; Malikowski, W. DEGUSSA Deutsche Gold- und Silber-Scheideanstalt, Hanau (Germany); Mercedes-Benz AG, Stuttgart (Germany); Feldmuehle AG, Plochingen (Germany); Karlsruhe Univ. (T.H.) (Germany). Inst. fuer Werkstoffkunde 1; Karlsruhe Univ. (T.H.) (Germany). Inst. fuer Zuverlaessigkeit und Schadenskunde im Maschinenbau. Apr 1990. 98p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 03M2014. Order Number DE95733455. Source: OSTI; NTIS (US Sales Only).

Active solders were developed by which both ZrO_2, Al_2O_3 and Si_3N_4 can be reliably joined. By the development of ductile active solders and the optimisation of the joint geometry, high adhesion can be achieved with simultaneous low stresses in the ceramic. The rocker arm was chosen as the component on which a ceramic layer is to be soldered for protection against wear. The ceramics to be soldered are zirconium oxide, Al_2O_3 dispersion ceramic and silicon nitride. Apart from the requirement for good adhesion, the stresses in the metal/ceramic compound material must simultaneously be minimised. The stresses are caused by the different thermal expansions of ceramics and steel. (orig.). 3 tabs., 91 figs.

6246 (INIS-mf–14412, pp. 66-67) **Preparation of high purity boron for doping silicon used for manufacturing of integrated circuits.** Nowicki, A. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)). Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. 118p. In *Annual report 1993*. Order Number DE95608338. Source: OSTI; NTIS; INIS.

Short communication. 4 refs., 1 fig. BORON/purification; BORON/semiconductor materials; BORON; PURIFICATION; CRYSTAL DOPING; DOPED MATERIALS; INTEGRATED CIRCUITS; SILICON

6247 (JAERI-Research–94-016) **Evaluation of strength properties of developed SiC/C compositionally gradient graphite materials.** Nakano, Junichi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Fujii, Kimio; Shindo, Masami. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1994. 29p. (In Japanese). Order Number DE95737271. Source: OSTI; NTIS; INIS.

To evaluate the influence of surface SiC coating and intermediate SiC/C layers on the mechanical strength of graphite matrix of the developed compositionally gradient graphite materials, which are composed of a surface SiC coating layer, an intermediate SiC/C layer and a graphite matrix, bending and compressive tests were carried out for SiC/C compositionally gradient graphite materials, SiC coated graphite materials, graphite materials with the intermediate SiC/C and virgin graphite materials at room temperature. The results of the tests were discussed in comparison with the specific surface areas which is a measure for the surface condition of samples. For the graphite with the intermediate SiC/C layer, the strength was independent of the Si content in the intermediate SiC/C layer and almost the same as that for the graphite substrate, although the specific surface area increased with an increase in the Si content in the intermediate SiC/C layer. The strength of the surface SiC coated specimens, i.e., SiC/C compositionally gradient graphite materials and SiC coated graphite materials, was about twice as that of the respective substrate, i.e., the graphite with the intermediate SiC/C layer and the virgin graphite. (author).

6248 (LA-UR–94-3470) **Vibration testing of the I-40 bridge before and after the introduction of damage.** Farrar, C.R.; Cone, K.M. Los Alamos National Lab., NM (United States). [1994]. 8p. Sponsored by Federal Highway Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950240–3: International modal analysis conference, Nashville, TN (United States), 13-16 Feb 1995). Order Number DE95002711. Source: OSTI; NTIS; GPO Dep.

Because the bridges over the Rio Grande were to be razed, the investigators were able to introduce simulated cracks in four stages of increasing length into the structure. This paper summarizes the results of ambient and conventional, measured-input, modal analyses, performed on the undamaged structure. Also summarized are the results of conventional modal analyses performed after each stage of damage had been introduced. These tests were intended to quantify the amount of damage necessary to produce changes in the global dynamic properties of the bridge and to form a data base that can be used by other investigators to develop damage identification algorithms. Conventional modal analysis identified changes in the global dynamic properties of the structure only after the final stage of a damage.

6249 (LA-UR–94-3958) **Composite ductility: The role of reinforcement and matrix.** Shi, N. (Los Alamos National Lab., NM (United States)); Arsenault, R.J. Los Alamos National Lab., NM (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Contract N00014-9410118. (CONF-950201–1: Annual meeting and exhibition of the Minerals, Metals and Materials Society, Las Vegas, NV (United States), 12-16 Feb 1995). Order Number DE95003664. Source: OSTI; NTIS; GPO Dep.

The total ductility, i.e., the energy required to rupture a ductile solid is controlled by two factors: (1) ability to withstand strain hardening before initiation of critical nuclei for final rupture (microcracks or voids); (2) resistance to crack extension. The first group is related to the reinforcement; particle or whisker fracture, debonding and void nucleation and growth at the reinforcement-matrix interface. The second group is related to the matrix; triaxial stress state in matrix, the work hardened state of the matrix due to the ΔCTE effect, and localized matrix plastic flow. The experimental data and theoretical analysis show that the lack of strain hardening capacity of the matrix is the major contributing factor causing the low ductility of DMMCS (discontinuous metal matrix composities). This may be attributed intrinsically to the exhaustion of the strain hardening capacity from ΔCTEinduced work hardening and/or extrinsically to the high matrix triaxial stresses which induces rapid void growth.

6250 (LA-UR–94-4043) **Internal strain measurement using pulsed neutron diffraction at LANSCE.** Goldstone, J.A. (Los Alamos National Lab., NM (United States). Manuel Lujan Jr. Neutron Scattering Center); Bourke, M.A.M.; Shi, N. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–11: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003677. Source: OSTI; NTIS; INIS; GPO Dep.

The presence of residual stress in engineering components can effect their mechanical properties and structural integrity. Neutron diffraction in the only technique that can make nondestructive measurements in the interior of components. By recording the change in crystalline lattice spacings, elastic strains can be measured for individual lattice reflections. Using a pulsed neutron source, all lattice reflections are recorded in each measurement, which allows for easy examination of heterogeneous materials such as metal matrix composites. Measurements made at the Manuel Lujan Jr. Neutron Scattering Center (LANSCE) demonstrate the potential at pulsed sources for in-situ stress measurements at ambient and elevated temperatures.

6251 (LA-UR–94-4051) **Temperature effects on ion irradiation damage in $MgAl_2O_4$ spinel single crystals.** Yu, Ning; Sickafus, K.E.; Nastasi, M. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–7:

1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003679. Source: OSTI; NTIS; GPO Dep.

$MgAl_2O_4$ monecrystals, <100> oriented, were irradiated at 100 and 670 K with 370–400 KeV Xe ions to doses of (1-2) x 10^{16} Xe/cm^2. Microstructures of irradiated samples were examined by cross-sectional TEM at RT. A uniform layer of amorphous phase was found on the surface of spinel irradiated at 100 K. At the end of the damage range underlying the amorphous layer, a disordered transition layer resided on the undamaged substrate. The transition layer retained single crystallinity having epitaxial relation with underlying substrate. However, <220> reflections in the transition layer diminished compared to undamaged spinel. No amorphization was found in spinel irradiated at 670 K to 2 x ^{16} Xe/cm^2. Partial diminishing of intensity of <220> reflections was observed in the heavily damaged region. The missing or reduction of <220> reflections suggests that spinel experiences a structural transition from original cubic phase (a=0.808 nm) to a new cubic phase (a=0.404 nm). A phase sequence from the original spinel to a metastable spinel and then to an amorphous spinel has been found. Temperature dependence of metastable and amorphous phase formation showed that the accumulation efficiency of cation disorder decreases with increasing irradiation temperature due to the enhanced mechanism of interstitial-vacancy recombination.

6252 (LBL–35434) **Annealing of nitrogen-doped ZnSe at high pressures: Toward suppression of native defect formation.** Chen, A.L. (Lawrence Berkeley Lab., CA (United States)); Walukiewicz, W.; Haller, E.E.; Luo, H.; Karczewski, G.; Furdyna, J. Lawrence Berkeley Lab., CA (United States). Jul 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-940981–4: 21. international symposium on compound semiconductors, San Diego, CA (United States), 18-22 Sep 1994). Order Number DE95003420. Source: OSTI; NTIS; GPO Dep.

Pressure is shown to have a drastic effect an the annealing characteristics of p-type, nitrogen-doped ZnSe. Samples annealed in vacuum show decreased carrier concentrations and simultaneous formation of deep-donor-related luminescence, while samples annealed under pressure show suppression of this compensating donor. Results are interpreted as an increase in the formation energy of the compensating deep donor under pressure. In addition the samples annealed under pressure show emergence of a new, intense, green luminescence band centered at 2.44 eV. The magnitude of the shift of this Peak under applied stress suggests that it results from a recombination involving a deep acceptor.

6253 (LBL–36256) **Carbon doping of III-V compound semiconductors.** Moll, A.J. Lawrence Berkeley Lab., CA (United States). Sep 1994. 134p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95003431. Source: OSTI; NTIS; GPO Dep.

Focus of the study is C acceptor doping of GaAs, since C diffusion coefficient is at least one order of magnitude lower than that of other common p-type dopants in GaAs. C ion implantation results in a concentration of free holes in the valence band < 10% of that of the implanted C atoms for doses > 10^{14}/cm^2. Rutherford backscattering, electrical measurements, Raman spectroscopy, and Fourier transform infrared spectroscopy were amonth the techniques used. Ga co-implantation increased the C activation in two steps: first, the additional radiation damage creates vacant As sites that the implanted C can occupy, and second, it maintains the stoichiometry of the implanted layer, reducing the number of compensating native defects. In InP, the behavior of C was different from that in GaAs. C acts as n-type dopant in the In site; however, its incorporation by implantation was difficult to control; experiments using P co-implants were inconsistent. The lattice position of inactive C in GaAs in implanted and epitaxial layers is discussed; evidence for formation of C precipitates in GaAs and InP was found. Correlation of the results with literature on C doping in III-V semiconductors led to a phenomenological description of C in III-V compounds (particularly GaAs): The behavior of C is controlled by the chemical nature of C and the instrinsic Fermi level stabilization energy of the material.

6254 (LUTFD2-TFKF–1016/1-161(1994)) **Mass and energy dispersive recoil spectrometry of GaAs structures.** Hult, M. Lund Univ. (Sweden). Dept. of Nuclear Physics. 26 Aug 1994. 88p. Order Number DE95610891. Source: OSTI; NTIS; INIS.

Mass and energy dispersive Recoil Spectrometry (RS) using heavy ions at energies of about 0.2A-0.8A MeV has attracted much interest recently due to its potential for separately and unambiguously generating information on isotopic depth distributions. The principal advantages of mass and energy dispersive RS are that both light and heavy elements can be separately studied simultaneously and problems caused by chemical matrix effects are avoided since the technique is based on high energy nucleus-nucleus scattering. In order to elucidate reactions taking place in various GaAs structures, Time of flight-Energy (ToF-E) RS was developed to allow Ga and As to be studied separately down to depths of about 500-800 nm with a depth resolution of about 16 nm at the surface. This was shown in a study of an $Al_xGa_{1-x}As$ quantum-well structure. The benefits of using ToF-E RS on GaAs structures were further demonstrated in studies of Co/GaAs and $CoSi_2$/GaAs reactions, as well as in a study of the composition of MOCVD grown $Al_xGa_{1-x}As$. Most recoil measurements employed ^{127}I at energies of about 50-90 MeV as projectiles. The recoil detector telescope consisted of a silicon energy detector and two carbon foil time pick-off detectors separated by a variable flight length of 213.5-961 mm. The reactions taking place between various thin films and GaAs were also studied using complementary techniques such as XRD, XPS and SEM. Co was found to react extensively with GaAs, already at about 300 degrees C, making it unsuitable as a contact material. Thin films of Co and Si were found to react extensively with each other and to form $CoSi_2$ at 500 degrees C and above. $CoSi_2$, a low resistivity silicide, turned out to be stable on GaAs, at least up to 700 degrees C. Considerable grain growth could cause problems, however, in the use of $CoSi_2$-contacts. 112 refs, figs, tabs.

6255 (NUTEK-FJV–94-6, pp. 1-38 (paper I)) **Thermal conductivity and gas diffusion of rigid PUR foam. Part 1. Study of thermal conductivity and gas analysis for PUR insulation made with the blowing agents CFC 11, HCFC 141b and CO_2.** Jarfelt, U. (Division of Building Technology, Chalmers University of Technology, Gothenburg (Sweden)). Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. Project NUTEK-656-101. In *CFC-free polyurethane foam.* 204p. Order Number DE95723995. Source: OSTI; NTIS.

The change in thermal conductivity as a function of time for rigid polyurethane foam made with different blowing agents has been studied in this project which is the first in a series of tests on different blowing agents and material properties. This first report sets out the results relating to the composition of the cell gases over a period of 100 days in slabs of polyurethane of different densities, made with different blowing agents, CO_2, CFC 11 and HCFC 141b. The test specimens were made in a high pressure machine, and the same mix compositions were used as far as possible. The polyol and isocyanate were not varied between the test materials. Differences in density were brought about by different degrees of over-packing. The thermal conductivity of slabs of 30 mm thickness was studied in a plate apparatus over a period of 100 days. Parallel with this determination, gas analyses were made on cell gas contained in the polyurethane material. On the bases of the partial pressure obtained, the diffusion coefficient for the blowing agents, oxygen and nitrogen was determined. 5 refs, 33 figs, 2 tabs

6256 (NUTEK-FJV–94-6, pp. 1-32 (paper II)) **A method for analysing the gas phase in polyurethane foam.** Ramnaes, O. (Division of Chemical Environmental Science, Chalmers University of Technology, Gothenburg (Sweden)); Svanstroem, M. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. Project NUTEK-656-101. In *CFC-free polyurethane foam.* 204p. Order Number DE95723995. Source: OSTI; NTIS.

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The insulative properties of a polymer foam depend upon the properties of the polymer, such as cell size, density and number of closed cells, and upon the thermal conductivities of the captive cell

gases. The blowing agents tend to diffuse out of and air into the foam. This diffusion leads to a change in the cell gas composition over time and a continuous increase in the thermal conductivity. It is consequently of interest to determine the cell gas composition of a foam at different times. Quantitative analyses of the cell gases can be used to study the ageing behaviour of a foam, to determine diffusion coefficients for different gases and to calculate the thermal conductivity of the foam. Different methods have been described for the determination of cell gas composition. In order to collect the gas phases from a large number of cells, the cell structure must be destroyed. This has been effected by cooling the sample in liquid nitrogen and then crushing the brittle foam. In the present work, a sampling method similar to that suggested by Du Cauze de Nazalle was used initially. The gas phase was collected when the foam was simultaneously twisted and compressed ('squeezed'). In order to eliminate the risk of an increased amount of blowing gas dissolving in the solid polymer during sampling, when the pressure is high, another sampling method, where the foam was ground, was tried. Both methods, the 'squeezer' and the 'grinder' method, are described in this report. 16 refs, 10 figs, 6 tabs

6257 (NUTEK-FJV–94-6, pp. 1-43 (paper III)) **Thermal conductivity of gaseous mixtures in foams. An evaluation of existing methods.** Wan, P. (Division of Heat and Power Technology, Chalmers University of Technology, Gothenburg (Sweden)); Vamling, L. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. Project NUTEK-656-101. In *CFC-free polyurethane foam.* 204p. Order Number DE95723995. Source: OSTI; NTIS.

Also published by Chalmers Univ. of Technology, Div. of Building Technology as Publ 94:1.

In this report, an evaluation of the existing calculation methods and a literature survey on the thermal conductivity of several insulating gas mixtures at atmospheric pressure were performed in the temperature range of 273K to 373K. The gases of primary interest were R11, R142b, CO_2, and air (N_2/O_2). The experimental thermal conductivities for the mixtures of CO_2/N_2, CO_2/air and $R11/N_2$ were compared with the estimated thermal conductivities calculated using three different methods. These methods were the one by Wassiljewa with Mason and Saxena modification, the one by Chung et al and a linear average of the thermal conductivity of the pure substances. From the comparison, the deviation was found to be, on average, less than 4%, except for the linear average of $R11/N_2$ mixture. The thermal conductivities of mixtures, $R11/CO_2/N_2/O_2$ and $R141b/CO_2/N_2/O_2$, were calculated using concentrations typical of aging foams. Three different methods were used and the percent deviation among these methods could be as much as 10%. The Wassiljewa equation is recommended for the calculation of the thermal conductivity of mixtures but more experimental data are needed in order to draw a more definitive conclusion. 21 refs, 9 figs, 10 tabs

6258 (NUTEK-FJV–94-6, pp. 1-20 (paper V)) **A symmetrical sample arrangement for accurate creep measurements on rigid PUR foams at elevated temperatures.** Bergstroem, G. (Swedish National Testing and Research Institute, Gothenburg (Sweden)); Karlsson, Jonas. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. Project NUTEK-656-101. In *CFC-free polyurethane foam.* 204p. Order Number DE95723995. Source: OSTI; NTIS.

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A symmetrical sample arrangement has been used to facilitate accurate measurement of the creep behaviour of closed cell PUR foams at elevated temperatures. Partly modelling the actual PUR foam boundary conditions in a district heating pipe, the symmetry of the measurement set-up balances dimensional changes caused by thermal expansion of the PUR structure and by changes in cell gas pressure. The rise in temperature causes the gas pressure in the closed cells to increase, and at the same time the changes in gas pressure accelerate due to higher gas diffusion rates. By applying the mechanical load on a symmetry plane, the zero point for creep measurement is stabilised by a factor of 10, and creep deformation can be measured virtually independently of changes in internal pressure. The measuring procedure produces elevated temperature data which do not suffer from the ambiguity of conventional TMA measurements. The creep properties of different PUR foam materials can therefore be compared directly irrespective of gas types etc. The measuring set-up described was successfully used on two reference PUR foams, FEBIS I (CFC blown) and FEBIS II (CO_2 blown). At a load of 50 kPa, the creep behaviour has been studied in the temperature range 23 degrees C - 170 degrees C over loading periods of up to 2000 hours. 4 refs, 14 figs

6259 (NUTEK-FJV–94-6, pp. 1-16 (paper VI)) **The load bearing capacity of CFC-free pre insulated district heating pipes at service temperature. Test method for determination of the axial shear strength of heating mains.** Jarfelt, U. (Division of Building Technology, Chalmers University of Technology, Gothenburg (Sweden)); Bergstroem, G.; Karlsson, Jonas. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. Project NUTEK-656-101. In *CFC-free polyurethane foam.* 204p. Order Number DE95723995. Source: OSTI; NTIS.

Also published by Chalmers Univ. of Technology, Div. of Building Technology as Publ 94:1.

The aim of the project was to develop test equipment for the determination of the axial shear strength of pre-insulated district heating pipes at service temperature. The test equipment complies with the requirements in EN 253, Rev. 5, where the service pipe temperature is maintained at 140 $\pm$ 2 degrees C. This temperature is reached within 30 minutes and is maintained for 30 minutes before the test load is applied. The axial shear strength of a number of pipe samples with CFC-blown, HCFC-blown and CO_2-blown foams has been determined at both room temperature, 23 degrees C, and service temperature, 140 degrees C. Non-aged and aged pipes (aged in accordance with EN 253, i.e. 170 degrees C for 1450 hours) were also tested. Pipes of the following makes were tested: Ecopipe, I.C. Moeller, Loegstoer, Powerpipe, Stjaernroer and Tarco. The measurements were made in short series, and comparisons between the different materials must therefore be made with care. The results indicate, however, that the axial shear strength of the CFC-free pipes is at the same level as that of traditional pipes. 2 refs, 6 figs

6260 (NUTEK-FJV–94-6, pp. 1-23 (paper VII)) **The load bearing capacity of CFC-free pre-insulated district heating pipes at service temperature. Creep due to radial compressive loading.** Jarfelt, U. (Division of Building Technology, Chalmers University of Technology, Gothenburg (Sweden)); Bergstroem, G.; Karlsson, Jonas. Swedish National Board for Industrial and Technical Development (NUTEK), Stockholm (Sweden). 1994. Project NUTEK-656-101. In *CFC-free polyurethane foam.* 204p. Order Number DE95723995. Source: OSTI; NTIS.

Also published by Chalmers Univ. of Technology, Div. of Building Technology as Publ 94:1.

The aim of this project has been to investigate the creep behaviour at service temperatures of rigid polyurethane foam for district heating mains. Measuring apparatus and a test method have been developed for the determination of radial compressive creep under controlled conditions. The project was financed by the Swedish District Heating Association and the Swedish Board for Industrial and Technical Development, NUTEK, and was carried out as a joint venture between Chalmers University of Technology, Gothenburg, Sweden, and the Swedish National Testing and Research Institute, Gothenburg, Sweden. The investigation took as a point of departure the existing standardised procedures for measurement of compressive creep, DIN 53425 (1965) and ISO 7860 (1986). These procedures have been modified in several respects to take account of problems due to high gas diffusion rates in the temperature range concerned, 100-140 degrees C. In order to understand and interpret the different test methods regarding softening temperature and radial creep, TMA measurements are compared with these creep measurements. The procedure developed has been used for measurements on CO_2-blown and CFC 11-blown polyurethane foams at 23, 120, 130 and 140 degrees C. The object was to gain experience of the procedure and to get an indication of the creep properties of the two materials. Since only two materials were tested, no general conclusions can be drawn, but results so far indicate only minor differences in creep behaviour.

Substantial differences were noted relative to TMA measurements. The results given by these are highly influenced by the measuring situation and shall not be interpreted as measurements of polyurethane material properties. 7 refs, 13 figs

6261 (ORNL/FMP–94/1, pp. 137-143) **Activation and micropore structure determination of carbon-fiber composite molecular sieves.** Derbyshire, F. (Univ. of Kentucky, Lexington, KY (United States)); Fei, Y.Q.; Jagtoyen, M.; Kimber, G.; Matheney, M.; Burchell, T. Oak Ridge National Lab., TN (United States). Aug 1994. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

Carbon fibers are produced commercially from rayon, phenolics, polyacrylonitrile (PAN), or pitch. The last are further divided into fibers produced from isotropic pitch precursors, and those derived from pitch that has been pretreated to introduce a high concentration of carbonaceous mesophase. Over the past few decades, interest in research and manufacturing carbon fibers has overwhelmingly centered on producing fibers with high tensile strength and high modulus for lightweight, high performance composites, where polymers, metals, and carbon can form the continuous matrix. The fibers most commonly used in advanced materials are produced from PAN or mesophase pitch. Graphitized mesophase pitch fibers tend to have higher modulus and lower tensile strength than the PAN-based equivalents. They have advantages in applications requiring high stiffness, high electrical and thermal conductivity, low thermal expansion, and high temperature oxidation resistance, while PAN fibers are employed where high strength is required.

6262 (UCRL-ID–112775, pp. 6.1-6.5) **Processing and characterization of laminated metal composites.** Syn, C.K.; Lesuer, D.R.; Sherby, O.D. Lawrence Livermore National Lab., CA (United States). Mar 1993. In *Materials Science and Engineering.* 30p. Order Number DE94003018. Source: OSTI; NTIS; GPO Dep.

In this work, the authors have made laminated metal composites of (1) ultrahigh carbon steel (1.8% C) and brass (70% Cu-30% Zn), and (2) Al 5182 and Al 6061-25 vol% SiC_p. The laminates were prepared by hot pressing alternating layers of the component materials in an argon gas atmosphere. Tensile and fracture toughness were measured for different processing conditions of surface oxide descaling, layer thickness, and heat treatment. Descaling of the surface oxide prior to the press bonding was found to eliminate premature delamination along interfaces, resulting in an increased yield strength and tensile ductility. Reduction in the layer thickness brought a large increase in tensile ductility, and a small decrease in yield strength and fracture toughness. T6 heat treatment on the Al laminates induced a substantial increase in the yield and tensile strength, but a decrease in tensile ductility. Fracture toughness measured both in the crack-arrester and crack-divider orientations showed a large enhancement over that of the component materials. Damping capacity measurements also showed rather remarkable increases over that of the component materials. 10 refs., 4 figs., 1 tab.

6263 (UCRL-ID–112775, pp. 6.17-6.21) **Fiber-optic Raman spectroscopy for cure monitoring of advanced polymer composites.** Lyon, R.E.; Myrick, M.L.; Vess, T.M.; Angel, S.M. Lawrence Livermore National Lab., CA (United States). Mar 1993. In *Materials Science and Engineering.* 30p. Order Number DE94003018. Source: OSTI; NTIS; GPO Dep.

The curing reaction of an epoxy resin matrix that is used for wet-filament-wound composites was monitored using Raman spectroscopy measured over fiber optics. The resin system consists of the diglycidyl ether of bisphenol-A in combination with a polyethertriamine hardener in a 1:1 stoichiometric ratio. The extent of chemical reaction of the epoxy as a function of time was measurable through changes in peak heights of several vibrational modes. A Raman peak associated with a phenyl ring vibration in the epoxide component was used as an internal reference to correct for density changes and instrumental variations. The feasibility of simultaneous temperature measurements was successfully demonstrated with the same fiber optics used to obtain the cure chemistry data, by measuring the intensity of anti-Stokes Raman scattering from the epoxy. 20 refs., 4 figs.

6264 (WSRC-TR–94-0527) **Stainless steel recycle FY94 progress report.** Imrich, K.J. Westinghouse Savannah River Co., Aiken, SC (United States). 28 Oct 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003905. Source: OSTI; NTIS; INIS; GPO Dep.

The Materials Technology Section (MTS) of the Savannah River Technology Center (SRTC) was asked to demonstrate the practicality of recycling previously contaminated stainless steel components such as reactor heat exchanger heads, process water piping and slug buckets into 208 liters (55 gallon) drums and 2.8 cubic meter (100 ft^3) storage boxes. Radioactively contaminated stainless steel scrap will be sent to several industrial partners where it will be melted, decontaminated/cast into ingots, and rolled into plate and sheet and fabricated into the drums and boxes. As part of this recycle initiative, MTS was requested to demonstrate that radioactively contaminated Type 304L stainless steel could be remelted and cast to meet the applicable ASTM specification for fabrication of drums and boxes. In addition, MTS was requested to develop the technical basis of melt decontamination and establish practicality of using this approach for value added products. The findings presented in this investigation lead to the following conclusions: recycle of 18 wt% Cr-8 wt% Ni alloy can be achieved by melting Type 304 stainless steel in a air vacuum induction furnace; limited melt decontamination of the contaminated stainless steel was achieved, surface contamination was removed by standard decontamination techniques; carbon uptake in the as-cast ingots resulted from the graphite susceptor used in this experiment and is unavoidable with this furnace configuration. A new furnace optimized for melting stainless steel has been installed and is currently being tested for use in this program.

40 CHEMISTRY

Refer also to citation(s) 6641, 6642

4001 Analytical and Separations Chemistry

Refer also to citation(s) 5088, 5105, 5254, 5317, 5409, 5502, 6001, 6812

6265 (CIEMAT–745) **A radiochemical procedure for a low-level measurement of ^{241}Am in environmental samples using a supported functional organo phosphorus extractant.** Gasco, C.; Anton, M.A.; Alvarez, A.; Navarro, N.; Salvador, S. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 56p. (In Spanish). Order Number DE95722439. Source: OSTI; NTIS; INIS.

The transuranides analysis in environmental samples is carried out by CIEMAT using standardized methods based on sequential separation with ionic-exchange resins. The americium fraction is purified through a two-layer ion exchange column and lately in an anion-exchange column in nitric acid methanol medium. The technique is time-consuming and the results are not completely satisfactory (low recovery and loss of alpha-resolution) for some samples. The chemical compound CMPO (octyl(phenyl).N,N-diisobutyl carbomoylmethyiphosphine oxide) dissolved in TPB (tributyl phosphate) and supported on an inert substrate has been tested directly for ^{241}Am analysis by a large number of laboratories. A new method that combines both procedures has been developed. The details of the improved procedure are described in this paper. The advantages of its application to environmental samples (urine, faeces and sediments) are discussed. The utilization of standard, with americium certified concentrations confirms the reliability of our measurements.

6266 (CONF-940414–6) **Simple chemical assays for presence of S_2F_{10} in decomposed SF_6.** Griffin, G.D.; Baker, M.R.; Sauers, I. Oak Ridge National Lab., TN (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From 7. international symposium on

gaseous dielectrics; Knoxville, TN (United States); 24-28 Apr 1994. Order Number DE95001423. Source: OSTI; NTIS; GPO Dep.

Disulfur decafluoride (S_2F_{10}; also referred to as sulfur pentafluoride) is a highly toxic gas which can be produced by electrical discharges in SF_6. It would be very useful, both for safety in handling decomposed SF_6 and for diagnosis of fault conditions, to have a convenient, rapid and sensitive field assay for the presence of S_2F_{10}. A number of different assays for S_2F_{10} with varying levels of sensitivity have been developed in the course of a CRADA initiative "Investigation of S_2F_{10} Production and Mitigation in Compressed SF_6-Insulated power Systems." These techniques include GC-MS, cryogenic GC enrichment and IR absorption. Although all of these procedures have been shown to have utility in detecting S_2F_{10}, and some have great sensitivity, they do not, in general, lend themselves to rapid field analyses. Ideally, one might wish to have an assay modeled after the "Draeger Tubes," where a gas sample is drawn through some chemical compound, and the resulting color change can be used to quantify the gas of interest. Disulfur decafluoride had been rather extensively studied in World War II as a candidate chemical warfare agent, and along with biological studies of its toxicity, chemical detection techniques had also been developed. Of the chemical assays described, two were particularly promising, one involving reaction of S_2F_{10} with NaI to produce free I_2 which could be titrated with sodium thiosulfate, and the other involving reaction of S_2F_{10} with p-phenylenediamine to produce a pink/red color. This second assay appeared to hold some promise, and accordingly, experiments were carried out to see if this assay could be useful for detecting S_2F_{10} in electrically decomposed SF_6 samples.

6267 (DOE/EM–0089T-Rev.2) **DOE methods for evaluating environmental and waste management samples.** Goheen, S.C.; McCulloch, M.; Thomas, B.L.; Riley, R.G.; Sklarew, D.S.; Mong, G.M.; Fadeff, S.K. (eds.). Pacific Northwest Lab., Richland, WA (United States). Oct 1994. 835p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (PNL–7722-Rev.2). Order Number DE95004428. Source: OSTI; NTIS; INIS; GPO Dep.

DOE Methods for Evaluating Environmental and Waste Management Samples (DOE Methods) is a resource intended to support sampling and analytical activities for the evaluation of environmental and waste management samples from U.S. Department of Energy (DOE) sites. DOE Methods is the result of extensive cooperation from all DOE analytical laboratories. All of these laboratories have contributed key information and provided technical reviews as well as significant moral support leading to the success of this document. DOE Methods is designed to encompass methods for collecting representative samples and for determining the radioisotope activity and organic and inorganic composition of a sample. These determinations will aid in defining the type and breadth of contamination and thus determine the extent of environmental restoration or waste management actions needed, as defined by the DOE, the U.S. Environmental Protection Agency, or others. The development of DOE Methods is supported by the Analytical Services Division of DOE. Unique methods or methods consolidated from similar procedures in the DOE Procedures Database are selected for potential inclusion in this document. Initial selection is based largely on DOE needs and procedure applicability and completeness. Methods appearing in this document are one of two types, "Draft" or "Verified". "Draft" methods that have been reviewed internally and show potential for eventual verification are included in this document, but they have not been reviewed externally, and their precision and bias may not be known. "Verified" methods in DOE Methods have been reviewed by volunteers from various DOE sites and private corporations. These methods have delineated measures of precision and accuracy.

6268 (ETDE/DE-mf–95733294) **Contribution to improvements in the analysis of extremely small trace amounts of platinum metals in biotic and ecologically relevant materials. Follow-up project. Final report.** Institut fuer Spektrochemie und Angewandte Spektroskopie (ISAS), Dortmund (Germany). 1993. 113p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 07VPT01A. Order Number DE95733294. Source: OSTI; NTIS (US Sales Only).

Different decomposition processes for the determination of platinum (adsorptive voltammetry, graphite furnace atomic absorption spectrometry) in biotic and ecologically relevant materials were tested. High-pressure decomposition in quartz vessels (max. 320 C and 130 bar) proved suitable for most sample types whereas open processes can only be recommended for single materials and small sample amounts. Radiochemical tracer-methods were used for testing decomposition, separation and concentration processes for determination of trace amounts of platinum. Studies were performed on ionic chromatographic methods, in particular on electrochemical detection. In-depth research was done into platinum species analysis for the example of grass samples that were either uncontaminated or contaminated with platinum. Platinum levels were determined in various biotic and ecologically relevant materials (uncontaminated and contaminated), especially in body fluids, air-borne particles, soils, fuels, water. (orig.)

6269 (ETDE/DE-mf–95733337) **Environment survey. Vol. 4a. Cadmium.** WaBoLu-Hefte, v. 2/1993. Schwarz, E.; Chutsch, M.; Krause, C.; Schulz, C.; Thefeld, W. Bundesgesundheitsamt, Berlin (Germany). Inst. fuer Wasser-, Boden- und Lufthygiene. 1993. 190p. (In German). Sponsored by Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany). Project Number UFOPLAN 11606057. Order Number DE95733337. Source: OSTI; NTIS (US Sales Only).

As part of the study 'Measurement and Analysis of Environmental Exposure Factors in the Federal Republic of Germany 1985/86 - Environment and Health', a representative sample of the population of the Federal Republic of Germany at that time aged 25 to 69 years was examined and interviewed. The most important elements of the survey were sampling of blood, urine and hair from the subjects, of dust and drinking water from their households, a questionnaire on 'Environment and Health' and another questionnaire with preferential orientation to 'Life and Health'. This study has demonstrated a number of joint characteristics for the cadmium concentrations in blood and urine. Cadmium in blood expresses above all the current cadmium burden while a chronic cadmium burden has only a minor influence on the cadmium level in blood. Cadmium in urine is above all an indicator of the total body burden from cadmium while the current burden is less readily recognizable from this parameter. However, attention should be given to the considerable influences of metabolic processes on the cadmium level in urine. Under normal conditions of exposure, the cadmium content of hair is unsuitable as an indicator; thus, it should not be used for evaluation instead of the cadmium levels in blood or urine. (orig./EF)

6270 (INIS-mf–14412, pp. 87-88) **Multivariate calibration and quantitation using artificial neutral networks.** Kierzek, J. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)); Malozewska-Bucko, B.; Kierzek, A. Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. 118p. In *Annual report 1993*. Order Number DE95608338. Source: OSTI; NTIS; INIS.

Short communication. 9 refs., 3 figs., 1 tab. X-RAY FLUORESCENCE ANALYSIS/calibration; X-RAY FLUORESCENCE ANALYSIS/neural networks; POLYMETALLIC ORES; QUANTITATIVE CHEMICAL ANALYSIS; CALIBRATION

6271 (LA–12874-MS) **Simulation of absorption edge densitometry.** Hsue, Sin-Tao; Collins, M. Los Alamos National Lab., NM (United States). Nov 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95004393. Source: OSTI; NTIS; GPO Dep.

A method for simulating absorption edge densitometry has been developed. This program enables one to simulate spectra containing any combination of special nuclear materials (SNM) in solution. The method has been validated with an analysis method using a single special nuclear material in solution or a combination of two types of SNM separated by a Z of 2. This computer simulation has been used to explore the bias caused by the presence of, for example, plutonium in a determination of uranium concentration. The authors have also used this program to explore better methods of analyzing densitometry data.

6272 (LA-SUB–94-133) **Final report on proposal to develop and test a membrane sampling module for the extraction of volatile organic compounds from water.** Cooks, R.G. (Purdue Univ., West Lafayette, IN (United States). Dept. of Chemistry). Los Alamos National Lab., NM (United States). 29 Jun 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003459. Source: OSTI; NTIS; GPO Dep.

A new technique is describe for the direct detection of volatile organic compounds in aqueous solutions at levels in the parts per trillion range. The sample is enriched in analyte in two consecutive stages, one utilizes a semi-permeable membrane interface and the other a jet separator. The analyte solution is sampled as it flows coaxially over a semi-permeable capillary membrane, the interior of which is continuously purged by helium. The permeate is pneumatically transported to the mass spectrometer via a jet separator, which is used to remove excess helium and water from the analyte vapor stream. Data are reported for an ion trap mass spectrometer used in conjunction with a conventional fixed-gap quartz jet separator. Typical analyte response times are 2-5 minutes and flow injection methods are used for sample delivery. Detection limits in the range 30 to parts per billion are observed for selected volatile organic compounds and the response is linear over 3 orders of magnitude. Details of the construction of the interface are provided.

6273 (LA-UR–94-1544) **RCRA materials analysis by laser-induced breakdown spectroscopy: Detection limits in soils.** Koskelo, A.; Cremers, D.A. Los Alamos National Lab., NM (United States). [1994]. 64p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94018613. Source: OSTI; NTIS; INIS; GPO Dep.

The goal of the Technical Task Plan (TTP) that this report supports is research, development, testing and evaluation of a portable analyzer for RCRA and other metals. The instrumentation to be built will be used for field-screening of soils. Data quality is expected to be suitable for this purpose. The data presented in this report were acquired to demonstrate the detection limits for laser-induced breakdown spectroscopy (LIBS) of soils using instrument parameters suitable for fieldable instrumentation. The data are not expected to be the best achievable with the high pulse energies available in laboratory lasers. The report presents work to date on the detection limits for several elements in soils using LIBS. The elements targeted in the Technical Task Plan are antimony, arsenic, beryllium, cadmium, chromium, lead, selenium, and zirconium. Data for these elements are presented in this report. Also included are other data of interest to potential customers for the portable LIBS apparatus. These data are for barium, mercury, cesium and strontium. Data for uranium and thorium will be acquired during the tasks geared toward mixed waste characterization.

6274 (ORNL/FMP–94/1, pp. 63-70) **Carbon fiber composite molecular sieves.** Burchell, T.D. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). Aug 1994. DOE Contract AC05-84OR21400. (CONF-9405143–: 8. annual conference on fossil energy materials, Oak Ridge, TN (United States), 10-12 May 1994). In *Proceedings of the Eighth Annual Conference on Fossil Energy Materials.* 451p. Order Number DE95001055. Source: OSTI; NTIS; GPO Dep.

The separation of gases is widely effected via the Pressure Swing Adsorption process. Here we report the synthesis and characterization of a novel adsorbent carbon materials called Carbon Fiber Composite Molecular Sieve. The unique combination of properties exhibited by this material makes it ideal for application in Pressure Swing Adsorption Systems, where its utilization will result in significant gains in process economics.

6275 (ORNL/TM–12785) **Citrate based "TALSPEAK" lanthanide-actinide separation process.** Del Cul, G.D.; Bond, W.D.; Toth, L.M.; Davis, G.D.; Dai, S.; Metcalf, D.H. Oak Ridge National Lab., TN (United States). Sep 1994. 54p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95002059. Source: OSTI; NTIS; INIS; GPO Dep.

The potential hazard posed to future generations by long-lived radionuclides such as the transuranic elements (TRU) is perceived as a major problem associated with the use of nuclear power. TRU wastes have to remain isolated from the environment for "geological" periods of time. The costs of building, maintaining, and operating a "geological TRU repository" can be very high. Therefore, there are significant economical advantages in segregating the relatively low volume of TRU wastes from other nuclear wastes. The chemical behavior of lanthanides and actinides, 4f and 5f elements respectively, is rather similar. As a consequence, the separation of these two groups is difficult. The "TALSPEAK" process (Trivalent Actinide Lanthanide Separations by Phosphorus-reagent Extraction from Aqueous Complexes) is one of the few means available to separate the trivalent actinides from the lanthanides. The method is based on the preferential complexation of the trivalent actinides by an aminopolyacetic acid. Cold experiments showed that by using citric acid the deleterious effects produced by impurities such as zirconium are greatly reduced.

6276 (SAND–94-2817C) **Chemical recognition software.** Wagner, J.S.; Trahan, M.W.; Nelson, W.E.; Hargis, P.J. Jr.; Tisone, G.C. Sandia National Labs., Albuquerque, NM (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9411144–3: Optical sensing for environmental and process monitoring, McLean, VA (United States), 7-10 Nov 1994). Order Number DE95003346. Source: OSTI; NTIS; GPO Dep.

We have developed a capability to make real time concentration measurements of individual chemicals in a complex mixture using a multispectral laser remote sensing system. Our chemical recognition and analysis software consists of three parts: (1) a rigorous multivariate analysis package for quantitative concentration and uncertainty estimates, (2) a genetic optimizer which customizes and tailors the multivariate algorithm for a particular application, and (3) an intelligent neural net chemical filter which pre-selects from the chemical database to find the appropriate candidate chemicals for quantitative analyses by the multivariate algorithms, as well as providing a quick-look concentration estimate and consistency check. Detailed simulations using both laboratory fluorescence data and computer synthesized spectra indicate that our software can make accurate concentration estimates from complex multicomponent mixtures even when the mixture is noisy and contaminated with unknowns.

6277 (WHC-EP–0822) **Assessment report for Hanford analytical services quality assurance plan.** Taylor, L.H. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 293p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003994. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the assessment results of DOE/RL-94-55, Hanford Analytical Services Quality Assurance Plan. The assessment was conducted using the Requirement and Self-Assessment Database (RSAD), which contains mandatory and nonmandatory DOE Order statements for the relevant DOE orders.

6278 (WHC-SD-WM-DP–068) **Concrete samples for organic samples, data package and 222-S validation summary report. Addendum 1A.** Vogel, R.E. Westinghouse Hanford Co., Richland, WA (United States). 1 Nov 1994. 559p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (WHC-SD-WM-DP–068-Add.1A). Order Number DE95003075. Source: OSTI; NTIS; INIS; GPO Dep.

This document is in two parts: the first is the data package entitled "Concrete Samples for Organic Samples" and the second is entitled "Concrete Samples for Organic Samples – Addendum 1A" which is the 222-S validation summary report.

4002 Inorganic, Organic, and Physical Chemistry

Refer also to citation(s) 4897, 4898, 4909, 5170, 6012, 6115, 6116, 6302, 6530, 6532, 6569, 6829

6279 (DOE/ER/13296–11) **The transformation of organic amines by transition metal cluster compounds: Progress report.** Adams, R.D. South Carolina Univ., Columbia, SC (United States). Dept. of Chemistry. Nov 1994. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-84ER13296. Order Number DE95004180. Source: OSTI; NTIS; GPO Dep.

Research during the current award period has covered several related topics which have emerged and grown as a consequence of the various discoveries that have been made during this award period. They have been divided into the following subsections for clarity and emphasis: The activation of tertiary amines by osmium cluster complexes; CH bond activation and ring opening of a nitrogen containing strained ring heterocycle by an osmium cluster complex; Ring opening of cyclic thioethers; cyclooligomerization of Thietanes; Studies of the cyclobutyne ligand; Insertion of an alkynes into metal-metal bonds; and Energy storage in metal clusters. A summary of the results of these studies is given in the following sections of this report. These studies have resulted in 50 scientific publications over the last three years and details of their studies beyond that given in the following sections can be found in those reports. All of these reports are listed in the final section of this report by the author's names, title and journal citation.

6280 (DOE/ER/13406–9) **Organometallic chemistry of bimetallic compounds. Progress report, January 1992–July 1995.** Casey, C.P. Wisconsin Univ., Madison, WI (United States). Jul 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER13406. Order Number DE95004436. Source: OSTI; NTIS; INIS; GPO Dep.

Four main projects at the interface between organometallic chemistry and homogeneous catalysis were pursued. All were designed to give increased understanding of the mechanisms of organometallic reactions related to homogeneous and heterogeneous catalysis. In addition, a minor study involving η^5-to η^1-cyclopentadienyl ring slippage in catalysis was completed.

6281 (DOE/ER/13775–6) **Group transfer and electron transfer reactions of organometallic complexes.** Atwood, J.D. State Univ. of New York, Buffalo, NY (United States). Dept. of Chemistry. [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER13775. Order Number DE95003732. Source: OSTI; NTIS; GPO Dep.

During 1994, despite the disruptions, the authors have made progress in several aspects of their research on electron transfer reactions between organometallic complexes. This summary covers three areas that are relatively complete: (1) reactions between metal carbonyl anions and metal carbonyl halides, (2) reactions of hydrido- and alkyl-containing anions ($RFe(CO)^-_4$ and $RW(CO)_5^-$) with metal carbonyl cations and (3) reactions of a seventeen-electron complex ($Cp_*Cr(CO)_3\bullet$) with metal carbonyl derivatives. Two areas of examination that have just begun (possible carbene transfer and the possible role of metal carbonyl anions in carbon-hydrogen bond activation) will also be described.

6282 (DOE/ER/13811–2) **Potential energy surfaces for chemical reactions. Progress report, March 15, 1988–1989.** Schaefer, H.F. III. Georgia Univ., Athens, GA (United States). Center for Computational Quantum Chemistry. [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-87ER13811. Order Number DE95004551. Source: OSTI; NTIS; GPO Dep.

The crystal structure of two esters, both coupled bicyclo[1.1.0] butane derivatives, are found to have extremely short carbon-carbon central bonds (1.440-1.445 angstroms). The phenomena is tested by quantum mechanical methods since chemical experiments are not currently possible. Theoretical models employed were the minimum basis set (MBS), the standard double zeta(DZ), the double zeta plus d(DZ+d), the double zeta plus polarization(DZ+P), along with the self-consistent field method provide predictions for intra-cyclic bond lengths and angles including the central bond length.

6283 (DOE/ER/14254–2) **Carbons and hydrogen by persistent metal radicals. Final report, April 1, 1993–October 31, 1994.** Department of Energy, Washington, DC (United States). Div. of Chemical Sciences. [1995]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-92ER14254. Order Number DE95003834. Source: OSTI; NTIS; GPO Dep.

The synthesis of complexed rhenium radicals is demonstrated from the reaction of sterically demanding phosphine with the triphenylmethyl complex $[\eta^5\text{-}CPh_3]Re(CO)_3$. Low yields are experienced unless high concentrations of phosphine ligands are employed with the mechanism of this reaction yet unknown. A complexed rhenium dimer is also synthesized, but in low yield. X-ray crystallography reveals that the sixth coordination site of the electron deficient rhenium cation (an extremely strong Lewis acid) is occupied by an agostic interaction with one of the pendant C-H bonds of the cyclohexyl ring of the complex. Preliminary results show that the rhenium complexes have a significantly different chemistry from similar tungsten analogs in reactivity and isotope exchange rates. It is hypothesized that the rhenium complexes would be useful in catalyzing the isotope exchange between water and hydrogen.

6284 (DOE/PC/93222–4) **NO decomposition in non-reducing atmospheres. Technical progress report, June 1994–August 1994.** Klier, K.; Herman, R.G.; Jirka, I. Lehigh Univ., Bethlehem, PA (United States). Sep 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG22-93PC93222. Order Number DE95004324. Source: OSTI; NTIS; GPO Dep.

This report summarizes the results obtained during optimization of conditions of ion exchange of Co^{2+} cations into zeolite A. The results are summarized as follows: The Co^{2+} species were introduced into Na A zeolite by contacting the zeolite with aqueous solution of cobalt (11) nitrate at pH ~6 and pH ~11. In both cases the expected ion exchange stoichiometry 1 Co^{2+}:2 Na^{1+} was exceeded, indicating intracavital precipitation and precipitation extraneous to the zeolite grains of excess cobalt species which likely consist of hydroxyoxides. All cobalt appeared to be divalent. Distribution of the Co^{2+} species was initially uniform in the preparation carried out at pH 6 but prolonged heat treatment resulted in the enrichment of cobalt in the external surface region of the zeolite. At pH 11, the initial distribution was nonuniform, with the Co^{2+} species enriched at the surface. The preparation did not achieve the intended exchange stoichiometry and indicated rather that more or less undefined cobalt (11) hydroxyoxide supported by the zeolite material, which could also be partially exchanged with cobalt, has been produced. Because in the catalytic applications reproducibility is essential, further preparations aiming at the desired exchange stoichiometry have been initiated in which lower pH will prevent precipitation of the hydroxyoxides. However, all the samples will be tested for NO decomposition to obtain a qualitative comparison between ion-exchanged and impregnated CoNaA zeolites.

6285 (LA-UR–94-3803) **Base hydrolysis and supercritical water oxidation of PBX-9404.** Flesner, R.L.; Spontarelli, T.; Dell'Orco, P.C.; Kramer, J.F.; Sanchez, J.A. Los Alamos National Lab., NM (United States). 9 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9411155–1: 1994 Luxembourg international symposium on the rehabilitation of military sites and demilitarization of explosive ordance, Kirchberg (Luxembourg), 14-18 Nov 1994). Order Number DE95003685. Source: OSTI; NTIS; GPO Dep.

Base hydrolysis in combination with hydrothermal processing has been proposed as an environmentally acceptable alternative to open burning/open detonation for degradation and destruction of high explosives. In this report, the authors examine gaseous and aqueous products of base hydrolysis of the HMX-based plastic bonded explosive, PBX-9404. The authors also examine products from the subsequent hydrothermal treatment of the base hydrolysate. The gases produced from hydrolysis of PBX-9404 are ammonia, nitrous oxide, and nitrogen. Major aqueous products are sodium formate, acetate, nitrate, and nitrite, but not all carbon products have been identified. Hydrothermal processing of base hydrolysate destroyed up to 98% of the organic carbon in solution, and higher destruction efficiencies are possible. Major gas products detected from hydrothermal processing were nitrogen and nitrous oxide.

6286 (LA-UR–94-3999) **Reflectivity studies on adsorbed block copolymers under shear.** Smith, G.S. (Los Alamos National Lab., NM (United States)); Wages, S.; Baker, S.M.; Toprakcioglu, C.; Hadziioannou, G. Los Alamos National Lab., NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–12: 1994 fall meeting of the Materials Research Society

(MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003676. Source: OSTI; NTIS; GPO Dep.

The authors report neutron reflectivity data on (poly)styrene-(poly)ethylene oxide (PS-PEO) diblock copolymers adsorbed onto quartz from the selective solvent cyclohexane (a non-solvent for PEO and a poor solvent for PS). The PEO "anchor block" adsorbs strongly to form a thin layer on the quartz substrate, while the deuterated PS chains dangle into the solvent. They find that under static conditions the density profile of the PS block in a poor solvent can be well described by a Schultz function which is indicative of a polymer "mushroom." Furthermore, they have studied the same system under shear at shear rates from 0–400s^{-1}. They find that there is a dramatic increase in the thickness of the PS layer under shear in cyclohexane and that the relaxation time from the shear-on profile back to the static profile is on the order of several days.

6287 (PSI–94-18) **Modelling of the near-field chemistry of the SMA repository at the Wellenberg site.** Neall, F.B. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Villigen (Switzerland). Sep 1994. 83p. Order Number DE95610661. Source: OSTI; NTIS; INIS.

Of the materials which make up the L/ILW repository for short-lived low- and intermediate-level wastes, around 95 weight percent consists of concrete, around 4% of steel and around 1% of high molecular weight organic waste components. In this report, models are used to evaluate the long-term stability of concrete, steel and high molecular weight organic components under repository conditions. The results of this study will then form the basis for describing release of radionuclides from the disposal caverns, and particularly the sorption of nuclides on concrete. In the disposal caverns, concrete is exposed to a range of processes which affect its stability. External processes include the leaching of hydrated cement by percolating groundwater, while internal processes include dissolution of repository components in cement porewater which can then react with the concrete. Of greatest significance in this respect are the high molecular weight organic waste components which degrade to organic acids in the disposal environment and then react with the basic components of the concrete. The leaching of hydrated cement is described, using a mixing tank model, as a sequence of batch experiments in which the same cement block reacts repeatedly with fresh groundwater. The model is based on the work by Berner (1990) but has been extended to include other solid cement phases and can, in a simple way, take account of the degradation of high molecular weight organics and their reaction with hydrated cement. The mixing tank model shows that, given the low water fluxes that are expected for a L/ILW repository, concrete remains stable over geological time spans provided only small volumes of high molecular organics are present. If high concentrations of these materials ar present, the longevity of the concrete may be reduced. (author) figs., tabs., refs.

6288 (PSI–94-19) **Physico-chemical characterisation and calculated in situ porewater chemistries for a low permeability Palfris marl sample from Wellenberg.** Baeyens, B. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Bradbury, M.H. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Nov 1994. 33p. Order Number DE95610662. Source: OSTI; NTIS; INIS.

Wellenberg (Gemeinde Wolfenschiessen, NW) has been chosen by Nagra as a repository site for short lived low- and medium-level radioactive waste. In certain regions of this Palfris marl formation, foreseen as actual locations for the repository, the water flow rates are so low that reliable water samples for chemical analysis were not obtainable. A sample of Palfris marl was provided from such a region and a physico-chemical characterisation technique, developed and tested in previous work, was applied. The measurements, coupled with a geochemical modelling study, yielded a NaCl type porewater with an ionic strength of $\simeq$0.12 M. In addition, a matrix marl porosity of $\simeq$1.5% was deduced using the chloride concentrations in the calculated porewater and measurements on the chloride content of marl. (author) 2 figs., 14 tabs., 12 refs.

4004 Electrochemistry

6289 (DOE/ER/45292–15) **NMR and optical studies of piezoelectric polymers. Final performance report, April 1, 1993–March 31, 1994.** Schmidt, V.H.; Tuthill, G.F. Montana State Univ., Bozeman, MT (United States). Dept. of Physics. [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-87ER45292. Order Number DE95003836. Source: OSTI; NTIS; GPO Dep.

The piezoelectric liquid crystal mixtures ZLI-2861, E7, and the copolymers of vinylidene fluoride are investigated with a variety of instrumental techniques including optical studies, nuclear magnetic resonance, and neutron scattering/diffraction. A unique AC thermal diffusivity apparatus was built to determine the specific heat and thermal conductivity of the liquid crystals. Included is an elastic and surface hypothesis for droplets of the liquid crystals. Statistical mechanics, such as the Monte Carlo method, determined that the electrically active polymers showed no percolation transition and that electrical forces play a dominant role in determining chain conformations. A molecular dynamics simulation of PVF_2 studied vibration spectrum, relaxation, and response to a switching field.

4005 Photochemistry

Refer also to citation(s) 6816

4006 Radiation Chemistry

Refer also to citation(s) 5493

6290 (INIS-mf–14420(Pt.1.2.3), [pp. 17]) **Radiation induced scavenging of NO_x, SO_2, H_2S from exhaust gases.** Nichipor, H.V. (AN Belorusskoj SSR, Minsk (Belarus)); Dashouk, E.M.; Yatsko, S.N. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.2.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The theoretical model of exhaust gases radiation induced oxidation was developed. NO, SO_2, H_2S concentration curves vs. dose calculated by the use of this model for mixtures containing N_2 (80.5%), O_2 (11%), H_2O (8.4%), NO (100-600 ppm), SO_2 (150-500 ppm), H_2S (300-1000 ppm) have been obtained. It was been shown that NO and SO_2 conversion reactions with acids formation go simultaneously with oxidizing reaction of H_2S giving SO_2 as an intermediate compound. These processes were evaluated for different initial concentrations of NO, SO_2 and H_2S. Data established by our simulation calculations show that the electron beam process can be judged as a promising technology for simultaneous removal of SO_2, NO and H_2S from exhaust gases. 11 refs, 7 figs.

6291 (INIS-mf–14420(Pt.1.2.3), [pp. 16]) **The effect of clusters and heterogeneous reactions on non-equilibrium plasma flue gas cleaning.** Potapkin, B.V. (Kurchatov Institute of Atomic Energy, Moscow (Russian Federation)); Deminsky, M.A.; Fridman, A.A.; Rusanov, V.D. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.2.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The heterogeneous reactions in droplets and clusters are essential in the evaluation of the chemical composition during plasma cleaning of the gases from SO_2, NO_x and H_2S. Theoretical investigation and the full modelling of SO_2 and NO_x purification in heterogenous non-equilibrium plasma has been presented. The main objective of author's approach modelling was to find the optimum regime of plasma generation (specific power, humidity, etc.) for essential decreasing of the purification energy cost. 24 refs, 6 figs, 1 tab.

6292 (INIS-mf–14420(Pt.1.2.3), [pp. 7]) **Investigation of SO_2 oxidation in humid air stream by high current density pulsed electron beam.** Baranchicov, E.I. (Kurchatov Institute of Atomic

Energy, Moscov (Russian Federation)); Belenky, G.S.; Deminsky, M.A.; Denisenko, V.P.; Maslenicov, D.D.; Potapkin, B.V.; Rusanov, V.D.; Spector, A.M.; Shulakova, E.V.; Fridman, A.A. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.3.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

It was proposed by Protapkin that the oxidation energy cost can be significantly reduced by using an effect of SO_2 plasma-catalytic oxidation. The new chain gas-cluster oxidation mechanism has been considered. The theoretical investigations as well as experimental results for verification of proposed mechanism have been shown and discussed. 13 refs, 1 fig.

6293 (LA-UR–94-4071) **Cation disorder determined by MAS ^{27}Al NMR in high dose neutron irradiated spinel.** Cooper, E.A. (Los Alamos National Lab., NM (United States)); Sickafus, K.E.; Hughes, C.D.; Earl, W.L.; Hollenberg, G.W.; Garner, F.A.; Bradt, R.C. Los Alamos National Lab., NM (United States). [1995]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–4: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003681. Source: OSTI; NTIS; GPO Dep.

Spinel ($MgAl_2O_4$) single crystals which had been neutron irradiated to high doses (53-250 dpa) were examined using ^{27}Al magic angle spinning (MAS) nuclear magnetic resonance (NMR). The sensitivity of this procedure to a specific cation (Al) residing in different crystallographic environments allowed one to determine the distribution of the Al between the two cation sites in the spinel structure. The samples were irradiated at two different temperatures (400 and 750°C) and various doses. These results indicate that the Al was nearly fully disordered over the two lattice sites after irradiation.

6294 (SLV–17-93) **Detection of irradiated food. Progress report 1989/90-1992/93.** Cerda, H. (Swedish Univ. of Agricultural Sciences, Uppsala (Sweden). Dept. of Radioecology); Nilson, Haakan. National Food Administration, Uppsala (Sweden). 20 Oct 1993. 45p. (In Swedish). Order Number DE95610865. Source: OSTI; NTIS; INIS.

In 1990 the Swedish National Food Administration was commissioned by the Ministry of Agriculture to prepare and develop methods of analysis to identify irradiated foods. This work has been done in cooperation with the Department of Radioecology, Swedish University of Agricultural Sciences. Two methods for analyses of irradiated foods have been developed; a chemical method for analysis of products containing fat, and a method for analysis of DNA in cells obtained from foods. Both methods have been tested within the Nordic cooperation programme and the BCR programme (Bureau Communautaire de Reference) organized by the EC. The chemical method for analysis of fats is already an established method that is approved for certain foods by authorities in, for example, Germany. The DNA approach is new and is considered to be a rapid screening method for use in combination with other methods. However, this method requires testing in cooperation with other laboratories before it can be accepted internationally. Laboratories from several countries are already using the method. The two methods described here make it possible to monitor foods such as chicken and duck that have been irradiated due to the risk of salmonella infection. Establishment of wider possibilities to monitor foods will require an additional method. One such method used today for several foods is the thermoluminescence method. This procedure can be used on prawns and other marine fauna, on spices, and possibly also on strawberries and tomatoes. It is an established approach and is used today for controls in most countries. 37 refs, 12 figs, 2 tabs.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 5290, 5327, 6436, 6437, 6603

6295 (ANL/RERTR/TM–19, pp. 313-333) **HEU and LEU MTR fuel elements as target materials for the production of fission molybdenum.** Sameh, A.A. (Nuclear Research Center Karlsruhe, Cyclotrone Lab., Karlsruhe (Germany)); Bertram-Berg, A. Argonne National Lab., IL (United States). Jul 1993. (CONF-9209266–: 1992 international meeting on reduced enrichment for research and test reactors, Roskilde (Denmark), 27 Sep - 1 oct 1992). In *Reduced enrichment for research and test reactors: Proceedings.* 376p. Order Number DE94012405. Source: OSTI; NTIS; INIS.

The processing of irradiated MTR-fuels for the production of fission nuclides for nuclear medicine presents a significantly increasing task in the field of chemical separation technology of high activity levels. By far the most required product is MO-99, the mother nuclide of Tc-99m which is used in over 90% of the organ function tests in nuclear medicine. Because of the short half life of Mo-99 (66 h) the separation has to be carried out from shortly cooled neutron irradiated U-targets. The needed product purity, the extremely high radiation level, the presence of fission gases like xenon-133 and of volatile toxic isotopes such as iodine-131 and its compounds in kCi-scale require a sophisticated process technology.

6296 (CIEMAT–734) **Optimization of the synthesis of a high specific activity "125 I-labelled hapten for radioimmunoassays.** Suarez, C.; Simon, M.A.; Paz, D.; Romero del Hombrebueno, B. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 17p. (In Spanish). Order Number DE95721641. Source: OSTI; NTIS; INIS.

In this first report it is described the synthesis, separation and purification of the 2-radioiodinated histamine "125 I-labelled histamine by a mixed anhydride reaction. About 75% incorporation of I"1125, from Na"125, I, was achieved with a molecular ratio of 1:1 mixed anhydride:histamine. The radiochemical purity of the conjugate by TLC was >99% and its theoretical specific activity, 3850 mu Ci/mug. Dissolved in ethanol and held at -20 degree centigree under darkness decomposition on storage did not exceed 1% per month.

6297 (LA-UR–94-3705) **Modeling actinide chemistry with ASPEN PLUS.** Grigsby, C.O. Los Alamos National Lab., NM (United States). [1995]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9411135–2: ASPENWORLD 94, Boston, MA (United States), 6-9 Nov 1994). Order Number DE95003716. Source: OSTI; NTIS; GPO Dep.

When chemical engineers think of chemical processing, they often do not include the US government or the national laboratories as significant participants. Compared to the scale of chemical processing in the chemical process, petrochemical and pharmaceutical industries, the government contribution to chemical processing is not large. However, for the past fifty years, the US government has been, heavily involved in chemical processing of some very specialized materials, in particular, uranium and plutonium for nuclear weapons. Individuals and corporations have paid taxes that, in part have been used to construct and to maintain a series of very expensive laboratories and production facilities throughout the country. Even ignoring the ongoing R & D costs, the price per pound of enriched uranium or of plutonium exceeds that of platinum by a wide margin. Now, with the end of the cold war, the government is decommissioning large numbers of nuclear weapons and cleaning up the legacy of radioactive wastes generated over the last fifty years. It is likely that the costs associated with the build-down and clean-up of the nuclear weapons complex will exceed the investment of the past fifty years of production. Los Alamos National Laboratory occupies a special place in the history of nuclear weapons. The first weapons were designed and assembled at Los Alamos using uranium produced in Oak Ridge, Tennessee or plutonium produced in Richland, Washington. Many of the thermophysical and metallurgical properties of actinide elements have been investigated at Los Alamos. The only plutonium processing facility currently operating in the US is in Los Alamos, and the Laboratory is striving to capture and maintain the uranium processing technology applicable to the post-cold war era. Laboratory researchers are actively involved in developing methods for

cleaning up the wastes associated with production of nuclear weapons throughout the US.

6298 (WHC-SD-CP-TP–079) **Test procedure for anion exchange chromatography.** Cooper, T.D. Westinghouse Hanford Co., Richland, WA (United States). 1 Sep 1994. 33p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003767. Source: OSTI; NTIS; INIS; GPO Dep.

Plutonium from stored nitrate solutions will be sorbed onto anion exchange resins and converted to storable plutonium dioxide. Useful information will be simultaneously gained on the thermal stability and ion exchange capacity of four commercially available anion exchange resins over several years and under severe degradative conditions. This information will prove useful in predicting the safe and efficient lifetimes of these resins.

6299 (WHC-SD-CP-TP–080) **Test procedure for cation exchange chromatography.** Cooper, T.D. Westinghouse Hanford Co., Richland, WA (United States). 24 Aug 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003770. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this test plan is to demonstrate the synthesis of inorganic antimonate ion exchangers and compare their performance against the standard organic cation exchangers. Of particular interest is the degradation rate of both inorganic and organic cation exchangers. This degradation rate will be tracked by determining the ion exchange capacity and thermal stability as a function of time, radiation dose, and chemical reaction.

4008 Combustion, Pyrolysis, and High-Temperature Chemistry

Refer also to citation(s) 5027, 6342, 6355, 7051

6300 (DOE/ID–10456) **Ignition of exploding aluminum droplets behind shock waves in water.** Theofanous, T.G.; Chen, X.; Di Piazza, P. California Univ., Santa Barbara, CA (United States). Center for Risk Studies and Safety. Sep 1994. 29p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003975. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This is an experimental study of the ignition of molten aluminum droplets in a well controlled and characterized simulated steam explosion environment. Ignition refers to the rapid oxidation of aluminum by steam, a reaction that can greatly augment the yield of the physical event (steam or thermal explosion). The simulated explosion environment was created in a hydrodynamic shock tube capable of producing sustained pressure pulses (2 ms duration) of amplitudes up to 50 MPa. The behavior of gram-quantities of molten aluminum droplets was studied as a function of their temperature in the 800°C (1073 K) to 1700°C (1973 K) range, and shock pressure, in the 6.8 to 40.8 MPa range. With the help of the resulting debris the authors have identified three main regimes of interaction: a "chemical" one where 100% of the melt has been converted to finely pulverized (micron size) α-$A\ell_2O_3$ and γ-$A\ell_2O_3$; a "partially-chemical" one where only some fraction (10 to 40%) of the debris met the above "chemical" characterization; and a "physical" regime where no "fines" or significant chemical oxidation of the melt was discernible. The work performed here involves extension of the working temperature range for shock tube research at UCSB to 1700°C and a breakthrough in demonstrating the effects of chemical reactions on the thermal interactions which had been the focus of fuel-coolant interaction (FCI) research.

6301 (ETDE/DE-mf–95733381) **Formation and behaviour of halogenated dibenzodioxins and dibenzofurans in thermal processes.** Zier, B. Technische Univ. Muenchen, Freising (Germany). Fakultaet fuer Landwirtschaft und Gartenbau. 2 Oct 1992. 117p. (In German). Order Number DE95733381. Source: OSTI; NTIS (US Sales Only).

The dissertation investigates the formation of halogenated dibenzodioxing and dibenzofurans in thermal processes. Bromine compounds are added to plastics as inflammation protection agents in concentrations of 5-20% by weight. A method of analysis was developed by which PBDD and PBDF of all degrees of bromination as well as PBCDD/PBCDF and PCDD/PCDF could be detected with high accuracy and sensitivity. Combustion experiments with different plastics showed that polybrominated diphenyl ethers have the most pronounced tendency to form PBDD and especially PBDF. Between 0.2% and 1% PBDF are produced independent of the degree of bromination of the ether. (BBR)

6302 (KFK–5274) **Formation of organic compounds at the reaction of toluene with fly ash in liquid and vapour phase.** Mandl, B. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Heisse Chemie; Heidelberg Univ. (Germany). Naturwissenschaftlich-Mathematische Gesamtfakultaet. May 1994. 195p. (In German). Order Number DE95731715. Source: OSTI; NTIS (US Sales Only).

Knowledge of reactions and reaction mechanisms of fly ash from municipal waste incineration plants leading to formation of organic compounds, is very important for minimizing the emission of these substances. Studying the reaction of toluene with fly ash is a contribution to this. During this reaction in liquid phase ($T \leq 111$ C), it could be shown that o- and p-methyldiphenylmethane were formed. This dimerisation of toluene describes the first step of an oxidation or condensation reaction, and their rate constant and activation energy were determined. Formally the reaction corresponds to zero order as often found in photochemical and catalytic reactions of metallic salts. Further following reactions forming oxidation or condensation products of the MDPMs could not be found in liquid phase. Parallel reactions such as chlorination of toluene up to the boiling point for example were not observed. Comprehensive thermodynamic evaluations in the suitable temperature range showed that the formation of following products is thermodynamically favoured. The different mineral phases of iron and copper are of special interest for chlorination of fly ash. Usually their chlorides are used as chlorinating agents at reactions with fly ash. It could be shown that these metallic salts are not available as water-soluble compounts. After dimerisation further following reactions have been observed in the vapour phase. In the presence of oxygen, oxidation products are formed and condensation products under inert gas atmosphere. In the decomposition of residual carbon of fly ash from 250 C on, addition of toluene to the vapour phase (80% N_2, 20% O_2) increased the formation of chlorinated aromatic compounds. Especially the lower chlorine stages have been preferred at the formation of dioxines and furanes. Thus fly ash is showing a potential of chlorination favouring the formation of organohalogen compounds in a gas-solid-phase (Abstract Truncated).

6303 (NEI-NO–464) **Mathematical modeling and numerical simulation of chemical kinetics in turbulent combustion.** Gran, I.R. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. May 1994. 229p. Order Number DE95723940. Source: OSTI; NTIS.

This thesis analyses turbulent reacting flows with emphasis on the interaction between the turbulence and the chemistry. First, the fundamental equations which govern laminar and turbulent reacting flows are presented. Three alternatives for representing the chemistry in turbulent combustion are studied. The simplest alternative is to assume fast chemistry. Detailed reaction mechanisms give a more accurate description of the chemistry, but are computationally expensive to use. The intrinsic low-dimensional manifold (ILDM) method for reducing the chemistry is an approach for obtaining an accurate representation of the chemistry at less computational effort. In order to be of practical use for turbulent flows, a statistical treatment of the governing equations is necessary. The outcome of such a treatment is either a set of transport equations for the probability density function (pdf). Regardless of which method is used, unknown terms that must be modeled, appear. The major difficulty in the moment-transport method is the closure of the mean chemical reaction term. Two methods to obtain this have been tested. One is based on viewing the smallest eddies of the turbulence as homogeneous reactors. This allows for a detailed treatment of the chemistry. The other approach assumes a particular shape for the pdf. When the transport equation for the pdf is solved, the effects of chemical reaction appear in closed form. The main difficulty in the pdf-transport method is the modeling of the effects of molecular diffusion on the pdf. Some kind of reduced chemistry is required

when using the pdf-transport method. The ILDM method is ideally suited for this. 153 refs., 94 figs., 6 tabs.

6304 (SAND–94-2639C) **Nonequilibrium multiphase mixture modeling of energetic material response.** Baer, M.R.; Hertel, E.; Bell, R. Sandia National Labs., Albuquerque, NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9410254–1: Nuclear explosives code developers conference (NECDC), Las Vegas, NV (United States), 27 Oct 1994). Order Number DE95003353. Source: OSTI; NTIS; GPO Dep.

To model the shock-induced behavior of porous or damaged energetic materials, a nonequilibrium mixture theory has been developed and incorporated into the shock physics code, CTH. Foundation for this multiphase model is based on a continuum mixture formulation given by Baer and Nunziato. In this nonequilibrium approach, multiple thermodynamic and mechanics fields are resolved including the effects of material relative motion, rate-dependent compaction, drag and heat transfer interphase effects and multiple-step combustion. Benchmark calculations are presented which simulate low-velocity piston impact on a propellant porous bed and experimentally-measured wave features are well replicated with this model. This mixture model introduces micromechanical models for the initiation and growth of reactive multicomponent flow which are key features to describe shock initiation and self-accelerated deflagration-to-detonation combustion behavior. To complement one-dimensional simulation, two dimensional numerical simulations are presented which indicate wave curvature effects due to the loss of wall confinement.

42 ENGINEERING

Refer also to citation(s) 5751, 6641, 6642

4202 Facilities, Equipment, and Techniques

Refer also to citation(s) 5024, 5025, 5114, 5132, 5199, 5203, 5223, 5224, 5225, 5228, 5245, 5251, 5269, 5281, 5283, 5286, 5300, 5302, 5319, 5426, 6003, 6104, 6106, 6107, 6117, 6123, 6141, 6264, 6632, 7015, 7032, 7035

6305 (CONF-950232–4) **Robust pose determination for autonomous docking.** Goddard, J.S.; Jatko, W.B.; Ferrell, R.K.; Gleason, S.S. Oak Ridge National Lab., TN (United States). [1995]. 9p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC05-84OR21400. From 6. American Nuclear Society meeting on robotics and remote systems; Monterey, CA (United States); 5-10 Feb 1995. Order Number DE95000687. Source: OSTI; NTIS; GPO Dep.

This paper describes current work at the Oak Ridge National Laboratory to develop a robotic vision system capable of recognizing designated objects by their intrinsic geometry. This method, based on single camera vision, combines point features and a model-based technique using geometric feature matching for the pose calculation. In this approach, 2-D point features are connected into higher-order shapes and then matched with corresponding features of the model. Pose estimates are made using a closed-form point solution based on model features of four coplanar points. Rotations are represented by quaternions that simplify the calculations in determining the least squares solution for the coordinate transformation. This pose determination method including image acquisition, feature extraction, feature correspondence, and pose calculation has been implemented on a real-time system using a standard camera and image processing hardware. Experimental results are given for relative error measurements.

6306 (DOE/MC/29115–95/C0403) **ARIES: A mobile robot inspector.** Byrd, J.S. South Carolina Univ., Columbia, SC (United States). Dept. of Electrical and Computer Engineering. [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC21-92MC29115. (CONF-950232–7: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95001589. Source: OSTI; NTIS; INIS; GPO Dep.

ARIES (Autonomous Robotic Inspection Experimental System) is a mobile robot inspection system being developed for the Department of Energy (DOE) to survey and inspect drums containing mixed and low-level radioactive waste stored in warehouses at DOE facilities. The drums are typically stacked four high and arranged in rows with three-foot aisle widths. The robot will navigate through the aisles and perform an autonomous inspection operation, typically performed by a human operator. It will make real-time decisions about the condition of the drums, maintain a database of pertinent information about each drum, and generate reports.

6307 (DOE/MC/30362–95/C0405) **BOA: Pipe-asbestos insulation removal robot system.** Schempf, H. (and others); Bares, J.; Mutschler, E. Carnegie-Mellon Univ., Pittsburgh, PA (United States). Robotics Inst. [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AR21-93MC30362. (CONF-950232–6: 6. American Nuclear Society meeting on robotics and remote systems, Monterey, CA (United States), 5-10 Feb 1995). Order Number DE95001590. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes the BOA system, a mobile pipe-external crawler used to remotely strip and bag (possibly contaminated) asbestos-containing lagging and insulation materials (ACLIM) from various diameter pipes in (primarily) industrial installations across the DOE weapons complex. The mechanical removal of ACLIM is very cost-effective due to the relatively low productivity and high cost involved in human removal scenarios. BOA, a mechanical system capable of removing most forms of lagging (paper, plaster, aluminum sheet, clamps, screws and chicken-wire), and insulation (paper, tar, asbestos fiber, mag-block) uses a circular cutter and compression paddles to cut and strip the insulation off the pipe through compression, while a HEPA-filter and encapsulant system maintain a certifiable vacuum and moisture content inside the system and on the pipe, respectively. The crawler system has been built and is currently undergoing testing. Key design parameters and performance parameters are developed and used in performance testing. Since the current system is a testbed, we also discuss future enhancements and outline two deployment scenarios (robotic and manual) for the final system to be designed and completed by the end of FY '95. An on-site demonstration is currently planned for Fernald in Ohio and Oak Ridge in Tennessee.

6308 (DOE/RL–94-106) **Needs assessment activity report.** USDOE Office of Environmental Restoration and Waste Management, Washington, DC (United States). Transportation Management Div. Aug 1994. 10p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95004145. Source: OSTI; NTIS; INIS; GPO Dep.

As part of a Transportation Management Division task (TMD), the Packaging Programs and Testing Group within Westinghouse Hanford Company (WHC) has assessed the packaging needs of some of the mid- and small-sized US Department of Energy (DOE) sites by visiting them and meeting with their transportation and packaging personnel. To date, ten DOE facilities have been visited. As a result, these sites have been informed of some of the packaging activities that TMD has sponsored and is sponsoring, have been apprised of possible upcoming changes to transportation regulations, have discussed their short-term packaging needs, and have shared unique packaging they have developed which may be of use to other DOE facilities.. This report summarizes the findings from visits to the following sites: Fermi National Laboratory; Argonne National Laboratory; New Brunswick Laboratory; EG and G Mound Applied Technologies; Fernald Environmental Management Project; West Valley Demonstration Project; Lawrence Berkeley Laboratory; Stanford Linear Accelerator Center; Brookhaven National Laboratory; and Princeton Plasma Physics Laboratory.

6309 (ETDE/DE-mf–95726909) **New piping techniques through insulated, compensating ductile cast iron socket pipes and efficient laying of supply pipes. Part-project: New techniques for service pipe insertion.** Zeller, A. Technische Werke der Stadt Stuttgart Antigua and Barbuda (TWS) (Germany). Hauptabteilung Rohrnetze fuer Gas, Wasser, Fernwaerme. Oct 1990. 165p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany);Forschungszentrum Juelich GmbH (Germany). Projekttraeger Biologie, Energie,

Oekologie. Foerderkennzeichen BMFT 0328789C. Order Number DE95726909. Source: OSTI; NTIS (US Sales Only).

The cost of piping considerably depends on the share of civil engineering works, i.e. on pavement scarifying and restoration, and on the extent to which digging impedes vehicle parking and traffic flow. Methods and machines which help to avoid scarifying were developed, therefore, as one was looking for ways of reducing the cost of gas and water pipe insertion. Already in the sixties the Technische Werke der Stadt Stuttgart AG utilities introduced the so-called Polish rocket with pneumatic steel cylinder. Displacing the soil the Polish rocket penetrates the ground leaving a hole about 100 mm in diameter for insertion of the gas or water pipe. Some recently developed types of that kind are provided with driving heads with built-in transmitters for position and height locating. Standard locating and control systems were not provided before the horizontal drilling methods were introduced. The new methods paved the way for greater drilling lengths. Today, the service pipe insertion method is also available for supply pipe laying parallel to the road axes. (orig./KO)

6310 (ETDE/DE-mf–95726910) **New piping techniques through insulated, compensating ductile cast iron socket pipes and efficient laying of supply pipes. Final report.** Zeller, A. Technische Werke der Stadt Stuttgart Antigua and Barbuda (TWS) (Germany). Hauptabteilung Rohrnetze fuer Gas, Wasser, Fernwaerme. Sep 1993. 151p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany);Forschungszentrum Juelich GmbH (Germany). Projekttraeger Biologie, Energie, Oekologie. Foerderkennzeichen BMFT 0328789C. Order Number DE95726910. Source: OSTI; NTIS (US Sales Only).

Easy-to-manufacture cast iron district heating pipes considerably reduce the cost of pipe construction. Mounting of the proven rubber joint socket ends used on drinking water pipes is less time-consuming and less expensive. Provided proper socket end designs, the thermal expansion of pipes is compensated. There is no need for complex systems for the compensation of temperature-dependent elongations. Controlled pipe displacements ensure very small supply pipe movements and an easier installation of outgoing service pipes. The replacement of steel pipes by cast iron pipes reduces the cost of piping because there is no need for sectional prestressing. Pipe sections can be mounted, therefore, and long, open ditches which are disadvantageous as regards high urban traffic densities can be avoided. Building site equipment advance payments can be reduced. (orig.)

6311 (INEL/MISC–94005) **Better define your customers facility requirements by optimizing your customers processes with value engineering before conceptual design.** Carpenter, R.L. Jr. EG and G Idaho, Inc., Idaho Falls, ID (United States). 19 Nov 1993. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Order Number DE95002033. Source: OSTI; NTIS; GPO Dep.

This paper addresses a new value engineering approach successfully being used at the Idaho National Engineering Laboratory (INEL) in the design process of major construction projects. Of particular interest is how value engineers are applying the principles of Total Quality Management (TQM), utilizing value engineering techniques. Discussed are the associated problems with how major construction projects were previously planned, designed, value engineered, and then redesigned. Benefits of applying value engineering techniques early-on in the design process, far ahead of the traditional time for VE execution, is examined. The author provides a pro-con analysis of the benefits of early-on value engineering effort, and uses data gathered from several value engineering studies to support the conclusions of this paper.

6312 (KCP–613-5500) **Integrated product definition representation for agile numerical control applications.** Simons, W.R. Jr.; Brooks, S.L.; Kirk, W.J. III; Brown, C.W. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Nov 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-9410197–2: Mid-America conference on intelligent systems, Overland Park, KS (United States), 27 Oct 1994). Order Number DE95003391. Source: OSTI; NTIS; GPO Dep.

Realization of agile manufacturing capabilities for a virtual enterprise requires the integration of technology, management, and work force into a coordinated, interdependent system. This paper is focused on technology enabling tools for agile manufacturing within a virtual enterprise specifically relating to Numerical Control (N/C) manufacturing activities and product definition requirements for these activities.

6313 (KCP–613-5502) **Feature-based tolerancing for advanced manufacturing applications.** Brown, C.W.; Kirk, W.J. III; Simons, W.R.; Ward, R.C.; Brooks, S.L. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Nov 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-9410253–1: Applications in manufacturing and services industries conference, Kansas City, MO (United States), 27-28 Oct 1994). Order Number DE95003390. Source: OSTI; NTIS; GPO Dep.

A primary requirement for the successful deployment of advanced manufacturing applications is the need for a complete and accessible definition of the product. This product definition must not only provide an unambiguous description of a product's nominal shape but must also contain complete tolerance specification and general property attributes. Likewise, the product definition's geometry, topology, tolerance data, and modeler manipulative routines must be fully accessible through a robust application programmer interface. This paper describes a tolerancing capability using features that complements a geometric solid model with a representation of conventional and geometric tolerances and non-shape property attributes. This capability guarantees a complete and unambiguous definition of tolerances for manufacturing applications. An object-oriented analysis and design of the feature-based tolerance domain was performed. The design represents and relates tolerance features, tolerances, and datum reference frames. The design also incorporates operations that verify correctness and check for the completeness of the overall tolerance definition. The checking algorithm is based upon the notion of satisfying all of a feature's toleranceable aspects. Benefits from the feature-based tolerance modeler include: advancing complete product definition initiatives, incorporating tolerances in product data exchange, and supplying computer-integrated manufacturing applications with tolerance information.

6314 (SAND–94-1624C) **An experimental algorithm for detecting damage applied to the I-40 bridge over the Rio Grande.** Mayes, R.L. Sandia National Labs., Albuquerque, NM (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950240–1: International modal analysis conference, Nashville, TN (United States), 13-16 Feb 1995). Order Number DE95001832. Source: OSTI; NTIS; GPO Dep.

An algorithm originally used to locate errors in finite element models is applied to a full scale bridge damage detection experiment. The method requires experimental frequency response function data measured at discrete locations along the major bridge load paths. In the bridge damage application the algorithm is most effective when applied to static flexibility shapes estimated with a truncated set of six mode shapes rather than individual mode shapes. The algorithm compares "before damage" and "after damage" data to locate physical areas where significant stiffness changes have occurred. A damage indicator shows whether damage is detectable. Damage is correctly located in the two most significant damage cases using the driving point static flexibility estimates. Limitations of the technique are addressed. The damage detection experiment was performed on a three span steel girder bridge that was 425 feet long. This bridge was part of Interstate 40 across the Rio Grande. The New Mexico State University Department of Civil Engineering organized the experiment. The frequency response functions were collected by Los Alamos National Laboratories personnel. The bridge excitation was provided by Sandia National Laboratories.

6315 (SAND–94-2215C) **Capillary flow on narrow strips and in V-shaped grooves.** Yost, F.G.; Holm, E.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950344–3: InterPack '95: international

electronic packaging conference, Maui, HI (United States), 26-30 Mar 1995). Order Number DE95000543. Source: OSTI; NTIS; GPO Dep.

Simple models for the flow of solder onto a copper metallized strip and into V-shaped groves in copper were derived and compared to experimental results. The conditions for initiation of flow are established and followed by the determination of flow rates for the two geometrical configurations. The analysis leads to the conclusion that the standard approach to capillary flow is adequate for describing these kinetics. A computer simulation using the interfacial energy minimization code Surface Evolver, is also used to examine these systems and it is shown that it does predict the experimentally observed morphologies. The two approaches are compared and similarities are discussed.

6316 (SAND–94-2368) **Simulation of impact of the Generic Accident-Resistant Packaging (GAP).** Slavin, A.M. Sandia National Labs., Albuquerque, NM (United States). Oct 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95003986. Source: OSTI; NTIS; INIS; GPO Dep.

Finite element simulations modelling impact of the Generic Accident-Resistant Packaging (GAP) have been performed. The GAP is a nuclear weapon shipping container that will be used by accident response groups from both the United States and the United Kingdom. The package is a thin-walled steel structure filled with rigid polyurethane foam and weighs approximately 5100 lbs when loaded. The simulations examined 250 ft/s impacts onto a rigid target at several orientations. The development of the finite element model included studies of modelling assumptions and material parameters. Upon completion of the simulation series, three full-scale impact tests were performed. A comparison of the simulation results to the test data is given. Differences between the results and data are examined, and possible explanations for the differences are discussed.

6317 (SAND–94-2375) **Application Protocol, Initial Graphics Exchange Specification (IGES), Layered Electrical Product.** O'Connell, L.J. (ed.). Sandia National Labs., Albuquerque, NM (United States). Dec 1994. 261p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004266. Source: OSTI; NTIS; GPO Dep.

An application protocol is an information systems engineering view of a specific product The view represents an agreement on the generic activities needed to design and fabricate the product the agreement on the information needed to support those activities, and the specific constructs of a product data standard for use in transferring some or all of the information required. This application protocol describes the data for electrical and electronic products in terms of a product description standard called the Initial Graphics Exchange Specification (IGES). More specifically, the Layered Electrical Product IGES Application Protocol (AP) specifies the mechanisms for defining and exchanging computer-models and their associated data for those products which have been designed in two dimensional geometry so as to be produced as a series of layers in IGES format The AP defines the appropriateness of the data items for describing the geometry of the various parts of a product (shape and location), the connectivity, and the processing and material characteristics. Excluded is the behavioral requirements which the product was intended to satisfy, except as those requirements have been recorded as design rules or product testing requirements.

6318 (SAND–94-2402C) **Optimal control design that accounts for model mismatch errors.** Kim, T.J. (Sandia National Labs., Albuquerque, NM (United States)); Hull, D.G. Sandia National Labs., Albuquerque, NM (United States). [1924]. 8p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950248–1: American Aeronautics Society/American Institute of Aeronautics and Astronautics Space flight mechanics meeting, Albuquerque, NM (United States), 13-15 Feb 1995). Order Number DE95002605. Source: OSTI; NTIS; GPO Dep.

A new technique is presented in this paper that reduces the complexity of state differential equations while accounting for modeling assumptions. The mismatch controls are defined as the differences between the model equations and the true state equations. The performance index of the optimal control problem is formulated with a set of tuning parameters that are user-selected to tune the control solution in order to achieve the best results. Computer simulations demonstrate that the tuned control law outperforms the untuned controller and produces results that are comparable to a numerically-determined, piecewise-linear optimal controller.

6319 (SAND–94-2681C) **The role of force measurements in advanced vibration test methods.** Smallwood, D.O. Sandia National Labs., Albuquerque, NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950240–2: International modal analysis conference, Nashville, TN (United States), 13-16 Feb 1995). Order Number DE95001833. Source: OSTI; NTIS; GPO Dep.

The role of force measurements in vibration testing is discussed. The rational for a vibration test based on the extremal control of force and acceleration is developed. The differences between force measurements in vibration testing and modal testing is discussed. Several methods for estimating the input force in a vibration test are outlined.

6320 (SAND–94-2702C) **A modal test design strategy for model correlation.** Carne, T.G.; Dohrmann, C.R. Sandia National Labs., Albuquerque, NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950240–4: International modal analysis conference, Nashville, TN (United States), 13-16 Feb 1995). Order Number DE95003631. Source: OSTI; NTIS; GPO Dep.

When a modal test is to be performed for purposes of correlation with a finite element model, one needs to design the test so that the resulting measurements will provide the data needed for the correlation. There are numerous issues to consider in the design of a modal test; two important ones are the number and location of response sensors, and the number, location, and orientation of input excitation. From a model correlation perspective, one would like to select the response locations to allow a definitive, one-to-one correspondence between the measured modes and the predicted modes. Further, the excitation must be designed to excite all the modes of interest at a sufficiently high level so that the modal estimation algorithms can accurately extract the modal parameters. In this paper these two issues are examined in the context of model correlation with methodologies presented for obtaining an experiment design.

6321 (SAND–94-2761) **Optical generation of radio-frequency power.** Hietala, V.M.; Vawter, G.A.; Brennan, T.M.; Hammons, B.E.; Meyer, W.J. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95005276. Source: OSTI; NTIS; INIS; GPO Dep.

An optical technique for high-power radio-frequency (RF) signal generation is described. The technique uses a unique photodetector based on a traveling-wave design driven by an appropriately modulated light source. The traveling-wave photodetector (TWPD) exhibits simultaneously a theoretical quantum efficiency approaching 100 % and a very large electrical bandwidth. Additionally, it is capable of dissipating the high-power levels required for the RF generation technique. The modulated light source is formed by either the beating together of two lasers or by the direct modulation of a light source. A system example is given which predicts RF power levels of 100's of mW's at millimeter wave frequencies with a theoretical "wall-plug" efficiency approaching 34%.

6322 (WHC-SD-CP-SA–023-Rev.1) **Structural evaluation of the 2736Z Building for seismic loads.** Giller, R.A. Westinghouse Hanford Co., Richland, WA (United States). 23 Sep 1994. 123p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003245. Source: OSTI; NTIS; INIS; GPO Dep.

The 2736Z building structure is evaluated for high-hazard loads. The 2736Z building is analyzed herein for normal and seismic loads and is found to successfully meet the guidelines of UCRL-15910 along with the related codes requirements.

6323 (WHC-SD-NR-CSER–010) **Criticality safety evaluation report for 300 Area N Reactor fuel fabrication and storage facility.** Schwinkendorf, K.N. Westinghouse Hanford Co., Richland, WA (United States). Dec 1993. 48p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94015643. Source: OSTI; NTIS; INIS; GPO Dep.

Criticality safety support calculations for the 300 Area Fuels Manufacturing Facility have been performed to update values currently found in the criticality prevention specifications. The old safe masses and associated dimensions table has been updated with new values, which were produced using more modern computer codes that comply with Software Quality Assurance (SQA) requirements. Monte Carlo calculations, using MCNP (Carter 1991), were performed to spot check these results, obtained using the WIMS-E code (Gubbins et. al. 1982). In addition, the criticality considerations associated with certain accident, or upset, conditions were analyzed. These scenarios include fire, the bringing together of multiple safe masses into one neutronically coupled system, mis-stacking, and accidental interspersed moderation.

6324 (WHC-SD-SQA-CSA–20382) **CSER 79-028, Addendum 2: Security bar addition to pedestal storage racks in Room 3 in 2736-Z Building.** Miller, E.M. Westinghouse Hanford Co., Richland, WA (United States). 18 Nov 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004147. Source: OSTI; NTIS; INIS; GPO Dep.

The Plutonium Finishing Plant (PFP) is installing security bars on plutonium storage racks in Room 3 in 2736-Z Building to meet International Atomic Energy Agency (IAEA) material control requirements. Figures show the existing arrangement and design of the security bars. The security bars are to be fabricated of aluminum or carbon steel. The detailed fabrication sketches are reproduced in Appendix C. The security bars are to be installed close to the chains of plutonium so a determination of their effect on criticality safety needs to be made. The addition of security bars to the storage array of 2.5 kg plutonium buttons in Room 3 can effect reactivity by reflecting neutrons back into the plutonium in the storage cans, by absorbing neutrons, and by moderating neutrons between stored plutonium buttons. The small amount of metal added by the storage bars in comparison to the amount of concrete in the walls and aluminum in the shelf monitors already in place would not significantly increase the k_{eff} of the storage array. Several computer calculations in previous analyses show that the security bars will have a negligible affect on reactivity.

6325 (WHC-SD-TP-DRR–003) **NFR TRIGA package design review report.** Clements, M.D. Westinghouse Hanford Co., Richland, WA (United States). 26 Aug 1994. 366p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE94018437. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this document is to compile, present and document the formal design review of the NRF TRIGA packaging. The contents of this document include: the briefing meeting presentations, package description, design calculations, package review drawings, meeting minutes, action item lists, review comment records, final resolutions, and released drawings. This design review required more than two meeting to resolve comments. Therefore, there are three meeting minutes and two action item lists.

6326 (WHC-SD-W320-DA–004) **Spool assembly support analysis.** Norman, B.F. Westinghouse Hanford Co., Richland, WA (United States). 7 Oct 1994. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003280. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the wind/seismic analysis and evaluation for the pump pit spool assemblies. Hand calculations were used for the analysis. UBC, AISC, and load factors were used in this evaluation. The results show that the actual loads are under the allowable loads and all requirements are met.

6327 (WHC-SD-W320-DA–005) **Shot loading platform analysis.** Norman, B.F. Westinghouse Hanford Co., Richland, WA (United States). 4 Oct 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003278. Source: OSTI; NTIS; INIS; GPO Dep.

This document provides the wind/seismic analysis and evaluation for the shot loading platform. Hand calculations were used for the analysis. AISC and UBC load factors were used in this evaluation. The results show that the actual loads are under the allowable loads and all requirements are met.

6328 (WHC-SD-WM-ER–390) **Stress analysis of shielded receiver lifting frame for core sampler truck #2.** Ziada, H.H. Westinghouse Hanford Co., Richland, WA (United States). 4 Nov 1994. 272p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003868. Source: OSTI; NTIS; INIS; GPO Dep.

This analysis evaluates the structural design adequacy of the shielded receiver lifting frame (SRLF) for the rotary mode core sampler truck number 2 (RMCST#2). The analysis considers the loads expected during operation of the SRLF. Most of the existing welds were not in conformance with those specified on the drawings, H-2-91715 and -91716 (RHO 1988a and RHO 1988b). Stress analysts and engineers examined the configuration of the welds connecting the frame members of the SRLF and those connecting the SRLF to the drill rig. In comparison to those shown on the drawing, some of the actual welds appear stronger and others undersized. For example, the actual fillet welds completely encircle the junctures of members, although the drawings show some welds to be on two sides only. Attempts to find the original design calculations were unsuccessful. To resolve the nonconformance, the critical welds were identified by analysis and subsequently inspected to ensure they are as large or larger than the minimum is defined by weld leg size. A required weld size, as determined by stress analysis, of 0.1 inch or larger is considered to be critical. This size was selected because no existing welds were found to be less than 0.125 inch. Analysis results led to weld modifications to strengthen the SRLF. The weld modifications performed are described in WHC 1994.

6329 (WHC-SD-WM-TI–654) **Documentation for initial testing and inspections of Beneficial Uses Shipping System (BUSS) Cask.** Lundeen, J.E. Westinghouse Hanford Co., Richland, WA (United States). 25 Aug 1994. 262p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001237. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this report is to compile data generated during the initial tests and inspections of the Beneficial Uses Shipping System (BUSS) Cask. In addition, this report will verify that the testing criteria identified in section 8.1 of the BUSS Cask Safety Analysis Report for Packaging (SARP) was met. The BUSS Cask Model R-1 is a type B shipping container used for shipment of radioactive cesium-137 and strontium-90 capsules to Waste Encapsulation and Storage Facility (WESF). The BUSS Cask body and lid are each one-piece forgings fabricated from ASTM A473, Type 304 stainless steel. The primary purpose of the BUSS Cask is to provide shielding and confinement as well as impact, puncture, and thermal protection for the capsules under both normal and accident conditions. Chapter 8 of the BUSS Cask SARP requires several acceptance tests and inspections, each intended to evaluate the performance of different components of the BUSS Cask system, to be performed before its first use. The results of the tests and inspections required are included in this document.

6330 (WHC-SD-WM-TI–659) **Documentation for first annual testing and inspections of Benificial Uses Shipping System (BUSS) Cask.** Lundeen, J.E. Westinghouse Hanford Co., Richland, WA (United States). 23 Aug 1994. 50p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001030. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this report is to compile date generated during the first annual tests and inspections of the Benificiai Uses Shipping System (BUSS) Cask. In addition, this report will verify that the testing criteria identified in chapter 8 of the BUSS Cask Safety Analysis Report for Packaging (SARP) was met. Section 8.2 "Maintenance and Periodic Inspection Program" of the BUSS Cask SARP requires that the following tests and inspections be performed on an annual basis: Hydrostatic pressure test; helium leak

test; dye penetrant test on the trunnions and lifting lugs; and torque test on all bolts; impact limiter inspection and weight test. The first annual inspections and testing of the BUSS Cask were completed on May 5, 1994, and met the SARP criteria.

6331 (WHC-SD-WM-TI–672) **Documentation for fiscal year 1995 annual BUSS cask SARP testing and inspections.** Saueressig, P.T. Westinghouse Hanford Co., Richland, WA (United States). 8 Nov 1994. 188p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003847. Source: OSTI; NTIS; INIS; GPO Dep.

The purpose of this report is to compile the data generated during the Fiscal Year (FY) 1995 annual tests and inspections performed on the Beneficial Uses Shipping System (BUSS) cask. The BUSS Cask Model R-1 is a type B shipping container used for shipment of radioactive cesium-137 and strontium-90 capsules to Waste Encapsulation and Storage Facility (WESF). The primary purpose of the BUSS Cask is to provide shielding and confinement as well as impact, puncture, and thermal protection for the capsules under both normal and accident conditions. Section 8.2 "Maintenance and Periodic Inspection Program" of the BUSS Cask SARP requires that the following tests and inspections be performed on an annual basis: hydrostatic pressure test; helium leak test; dye penetrant test on the trunnions and life lugs; torque test on all permanent bolts; and impact limiter inspection and weight test. In addition to compiling the generated data, this report will verify that the testing criteria identified in section 8.2 of the BUSS Cask Safety Analysis Report for Packaging (SARP) was met.

6332 (WHC-SD-WM-WP–289-Rev.1) **Engineering work plan for container venting system drill press assembly troubleshooting. Revision 1.** Prather, M.C. Westinghouse Hanford Co., Richland, WA (United States). Nov 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003992. Source: OSTI; NTIS; INIS; GPO Dep.

This work plan is for troubleshooting the current CVS drill press to ensure that the drill bit assembly doesn't bind in the press plate. A drill press assembly has been fabricated for the Container Venting System (CVS). The drill bit assembly has bound in the press plate in previous revisions of this design. Initial troubleshooting of the drill press per Rev. 0 of this work plan was performed at the 200W Kaiser Machine Shop under Work Package 2H9401670F, Internal Work Order E20027. The drill press operated without jamming. Then, during the pre-operational test on 11/14/17 and the operational test on 11/17/94, two drum lids were drilled. Immediately after the test on 11/17/94, the drill was again operated, and it jammed. An inspection found shavings at the bottom of the drill bit assembly, between the drill bit sleeve and the press plate bore. This revised work plan provides direction for the machine shop to diagnose and correct this recent problem.

6333 (WSRC-RP–94-1132) **Nuclear criticality safety analysis summary report: The S-Area Defense Waste Processing Facility sludge-only operation.** Ha, B.C. Westinghouse Savannah River Co., Aiken, SC (United States). [1995]. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. Order Number DE95003484. Source: OSTI; NTIS; INIS; GPO Dep.

The S-Area Defense Waste Processing Facility (DWPF) can process all of the high level radioactive wastes currently stored at the Savannah River Site with negligible risk of nuclear criticality under the sludge-only operation. The characteristics which make the DWPF critically safe are: (1) abundance of neutron absorbers in the waste feeds, (2) and low concentration of fissionable material. This report documents the criticality safety arguments for the S-Area sludge-only DWPF process as required by DOE orders to characterize and to justify the low potential for criticality. It documents that the nature of the waste feeds and the nature of the DWPF process chemistry preclude criticality. The DWPF coupled-free operation is covered under another summary report, WSRC-RP-94-396.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 5756, 5793, 5917, 6214, 6647, 7034, 7036, 7052

6334 (ANL–94/32) **Development of a small-channel nucleate-boiling heat transfer correlation.** Kasza, K.E.; Wambsganss, M.W. Argonne National Lab., IL (United States). Jun 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95004243. Source: OSTI; NTIS; GPO Dep.

Development of an improved semimechanistic-based set of correlation parameters for nucleation-dominant flow-boiling heat transfer in small channels is described. Formulation of these parameters is on the basis of a recently published open-literature model for vapor bubble growth at a heated surface. This work is part of a program directed at obtaining an understanding of the physical mechanisms that influence boiling in compact heat exchangers through the use of high-speed video and microscope optics to characterize bubble nucleation, growth, and interaction with the confining walls of small heat transfer passages. The correlation parameters presented here represent the first step in the development of an improved boiling correlation for geometrically confined small-channel flows. In such flows, the nucleating bubbles can become nominally the same size as the channel cross section, thereby invalidating existing correlations that are based on large-channel data. Initial efforts to correlate small-channel-boiling data obtained at Argonne National Laboratory from nontransparent electrically heated metal tube tests appear promising.

6335 (BNWL-SA–1767) **Mass transfer at the solid-liquid interface for climbing film flow in an annular duct.** Sutey, A.M.; Knudsen, J.G. Battelle-Northwest, Richland, WA (United States). Pacific Northwest Lab. 9 Apr 1968. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94018422. Source: OSTI; NTIS; GPO Dep.

A method utilizing a diffusion controlled electrochemical reaction was used to measure average and instantaneous mass transfer coefficients at the solid-liquid interface in upward gas-liquid climbing film flow in a vertical annular duct. These measurements give some indication of the mechanics of flow of the film, the extent of turbulence at the inner wall, and the effect of film thickness and wave motion on the mass transfer process at the inner wall. Predictions of incipient downflow of the film, shear stress at the inner wall, and interfacial shear stress were obtained from these measurements. Fluctuations in the velocity gradient at the inner wall were also studied. Results of this study are in fair agreement with previous work and with theoretical predictions based on simplified momentum balance concepts.

6336 (DLR-FB–93-54) **A model of droplet evaporation in a supercritical pressure environment.** Olthoff, P. Deutsche Forschungsanstalt fuer Luft- und Raumfahrt e.V. (DLR), Hardthausen am Kocher (Germany). Inst. fuer Chemische Antriebe und Verfahrenstechnik; Technische Univ. Braunschweig (Germany). Fakultaet fuer Maschinenbau und Elektrotechnik. Dec 1993. 162p. (In German). Order Number DE95733253. Source: OSTI; NTIS (US Sales Only).

Droplet evaporation in high temperature and high pressure environment has been investigated. In theoretical investigations of a further developed mathematical droplet evaporation model has been found the importance of the effects of non ideal gas behavior for the calculation of the mole or mass fraction for the vapor-liquid equilibrium at the droplet boundary and the effects of real enthalpy of vaporization. Therefore in a high pressure environment the effect of absorption is very important. Physical properties have to be calculated as a function of temperature and pressure. In order to make experiments a high pressure and high temperature experimental apparatus has been developed, in which the evaporation of a single heptane droplet in nitrogen gas environment could be observed and droplet size-time and temperature-time histories could be measured. The environmental gas pressure range was p_{Umg}=2-100 bar and the ambient gas temperature range was T_{Umg}=296-773 K. The theoretical and experimental results, also the experimental results of earlier experimentators, were in excellent correspondence. (orig.)

6337 (DOE/ER/14100–T1) **Hydrodynamic instabilities and coherent structures: Progress report, January 1, 1994–December 31, 1994.** Frenkel, A. Alabama Univ., University, AL (United States). Dept. of Mathematics. Aug 1991. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-90ER14100. Order Number DE95004213. Source: OSTI; NTIS; GPO Dep.

The authors have derived a 3-dimensional dissipative-dispersive evolution equation for the film thickness for films flowing down inclined planes. They have also derived dissipative-dispersive evolution equations for 3-dimensional waves on films flowing down vertical cylinders. They have obtained and simulated numerically highly nonlinear evolution equations describing large-amplitude waves in core-annular flows. They have completed the numerical proof of negativity of the isotropic eddy viscosity for a sinusoidally oscillating triangular-eddy flow. Finally, they have developed an unusual generalization of Landau's equation to describe the nonlinear evolution of certain (steady) periodic flows slightly above the onset of the (intermediate-wavelength) instability.

6338 (ETDE/DE-mf–95733422) **Ludwig Prandtl, a biography. Memories, documents.** Mitteilungen aus dem Max-Planck-Institut fuer Stroemungsforschung, v. 107. Vogel-Prandtl, J. Max-Planck-Institut fuer Stroemungsforschung, Goettingen (Germany). 1993. 229p. (In German). Order Number DE95733422. Source: OSTI; NTIS (US Sales Only).

With his fundamental contributions towards applied mechanics, hydrodynamics, aerodynamics and gas dynamics, Ludwig Prandtl played a decisive part in bringing about development in these fields of science in the first half of this century. His collected works were brought out in three volumes a few years after his death, which provided subsequent generations with access to many of his publications. Yet this written heritage only represents a part of the lifetime of work for which the world of science has to thank this brillant scholar. He also contributed a great deal in the suggestions and ideas which he made in the work of his many students, employees and research colleagues right around the world. He devised the theories of the boundary layer and the aerofoil; he expounded fundamental ideas on the flow of compressible media and on the turbulent movement of liquid; he applied flow physics to meteorology. His contributions to the problems of elasticity, plasticity and rheology are also very worthy of note. He was able to carry out intensive fundamental research work at the Kaiser-Wilhelm Institute of Flow Research in Goettingen, relieved of the burden of any external requirements. He enjoyed particular success combining theory and experiments. In addition to the theories mentioned above (both of which have been accorded his name), he also developed wind tunnels and measurement apparatus to assist him in his experiments (such as Prandtl's tube and Prandtl's manometer), revealing himself to be an allround scholar. (orig.)

6339 (NEI-NO–463) **Algebraic and elliptic grid generation for computational fluid dynamics (CFD) applications.** Oerbekk, E. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. 1994. 145p. Order Number DE95723939. Source: OSTI; NTIS.

Computer codes have been developed for both algebraic and elliptic grid generation procedures, including a number of interactive post processor codes both for grid generation and flow solution plots. The computer codes are all based on a multi-block structure and are programmed in FORTRAN. Algebraic grid generators are preferable when generating large and complex three-dimensional (3D) grids, this mainly since they are very fast compared with the elliptic technique. Another significant feature of the algebraic method is the ability of having a high degree of control over the mesh point distribution. Although, compared with the elliptic method, there is no doubt that elliptic generated grid is smoother and more equally distributed than algebraic generated grids. In order to take advantages of both grid generation methods, "the speed from the algebraic one and the smoothness of the elliptic one", a grid generator based on both methods is developed. The initial generated grid should be based on the algebraic grid generation procedure. Further grid refinements should be based on the elliptic method combined with the initial algebraic generated grid. An efficient combination requires that the source functions are solved from a "high quality" algebraic generated grid. In order to keep most of the generated grid structure as it is initially defined, only local changes of the source functions are desired. The source functions are smoothed by the Laplace equations using a forward explicit Euler scheme. Source functions are more or less only smoothed in regions with discontinuities, and these modified source functions are used in an elliptic grid generator. The resulting grid has automatically been smoothed in regions with discontinuities. Additional adding of elliptic tools such as automatic forcing towards orthogonality can be used. 31 refs., 95 figs.

6340 (ORNL/M–3986) **MPI implementation of CFD program PHOENICS.** Simunovic, S. (Oak Ridge National Lab., TN (United States). Metals and Ceramics Div.); Zacharia, T. Oak Ridge National Lab., TN (United States). 26 Oct 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95003896. Source: OSTI; NTIS; GPO Dep.

This document describes the work on Message Passing Interface (MPI) standard implementation of the parallel version of the solver EARTH for the Computational Fluid Dynamics (CFD) program PHOENICS. The Intel Paragon NX and MPI versions of the program have been developed and tested on massively parallel (MP) supercomputers Intel Paragon XP/S 5, XP/S 35, and Kendall Square Research (KSR) supercomputers at Oak Ridge National Laboratory (ORNL). The preliminary testing results of the developed program have shown scalable performance for reasonably sized computational domains.

6341 (PSI–94-16) **Development, implementation and assessment of specific closure laws for inverted-annular film-boiling in a two-fluid model.** Cachard, F. de (Paul Scherrer Inst. (PSI), Villigen (Switzerland)). Paul Scherrer Inst. (PSI), Villigen (Switzerland). Oct 1994. 96p. Order Number DE95611091. Source: OSTI; NTIS; INIS.

Inverted-annular film-boiling (IAFB) is one of the post-burnout heat transfer modes taking place, in particular, during the reflooding phase of the loss-of-coolant accident, when the liquid at the quench front is subcooled. Under IAFB conditions, a continuous liquid core is separated from the wall by a superheated vapour film. The heat transfer rate in IAFB is influenced by the flooding rate, liquid subcooling, pressure, and the wall geometry and temperature. These influences can be accounted by a two-fluid model with physically sound closure laws for mass, momentum and heat transfer between the wall, the vapour film, the vapour-liquid interface, and the liquid core. The applicability of existing IAFB two-fluid models is limited. This is attributed to shortcomings in the description of heat transfer within the liquid core, to use of certain correlations outside their validity range, and to a limited use of experimental information on IAFB. The usual approach has been to develop models employing generally applicable closure laws including, however, adjustable parameters, and to adjust these using global experimental results. The present approach has been to develop IAFB-specific closure laws in such a form that they could be adjusted separately using detailed, IAFB-relevant, experimental result. Steady-state results, including heat flux, wall temperature and void fraction data have been used for the adjustment. A key issue in IAFB modeling is to predict how the heat flux reaching the vapour-liquid interface is split into a liquid heating term and a vaporization term. In the model proposed, convective liquid heating is related to the liquid velocity relative to the interface, and not to the absolute liquid velocity, as in previous models. This relative velocity is deduced from the interfacial shear stress, using the liquid-interface friction law. With this modification, the prediction of the experimental trends is greatly improved. (author) figs., tabs., refs.

6342 (SAND–93-0765) **Bubble growth, shock waves, and flow transients produced by underwater capacitor discharges.** Nelson, L.S.; Hogeland, S.R.; Utash, J.L. Sandia National Labs., Albuquerque, NM (United States). Dec 1994. 69p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (NPRW-SA–92-11). Order Number DE95004279. Source: OSTI; NTIS (US Sales Only); GPO Dep.

As part of a combined theoretical and experimental effort to understand the initiation of steam explosions of molten aluminum, we have characterized bubble growth, shock waves and flow transients produced by high-voltage capacitor discharges through gold

bridgewires placed underwater. For the most part, our measured values have magnitudes adequate to test the applicability of Ciccarelli's new triggering mechanism to drops of molten aluminum. In appendices, we present preliminary results of experiments designed to chemically enhance the energies of the bubbles and shock waves generated by these underwater capacitor discharges.

6343 (SAND–94-2264C) **Solutions of turbulent backward-facing step flow with heat transfer using the finite volume method.** Horstman, R.H. (Boeing Commercial Airplane, Seattle, WA (United States). Environmental Control Systems R&D); Cochran, R.J.; Emergy, A.F. Sandia National Labs., Albuquerque, NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941142–26: American Society of Mechanical Engineers' winter annual meeting, Chicago, IL (United States), 9-11 Nov 1994). Order Number DE95003360. Source: OSTI; NTIS; GPO Dep.

The heated turbulent flow over a backward-facing step is numerically solved using the commercial computational fluid dynamics program FLUENT. The methods used here consist of the default power-law upwinding scheme, default multigrid equation solution method and a standard k-ε turbulence model with wall functions. A total of four separate cases are reported. The four cases consist of combinations of partially and fully developed flow at the inlet with uniform or developed temperature profiles. Three mesh refinements are reported for each flow.

6344 (SAND–94-8597C) **Turbulent dispersion of particles: The STP model.** Baxter, L.L. (Brigham Young Univ., Provo, UT (United States)); Smith, P.J. Sandia National Labs., Albuquerque, NM (United States). [1994]. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940277–4: Atmospheric radiation measurement science team meeting, Charleston, SC (United States), 28 Feb - 3 mar 1994). Order Number DE94016616. Source: OSTI; NTIS; GPO Dep.

A mathematical description of the stochastic transport of particles (STP) model for particle dispersion in turbulent flows is presented. The STP model is based on established theories of stochastic process modeling. The parameters of the model include physical properties of the particle (diameter and mass) and a description of the turbulent characteristics (mean velocities with rms fluctuations and their residence-time correlations) of the fluid phase in which the particles are dispersed. The model includes no adjustable parameters in the sense of calibration factors. It is independent of any particular turbulence model, but estimates of its parameters from information available from the common k-ε turbulence model are presented. Elements of the STP model are compared with exact solutions of the diffusion equation, alternative dispersion models, and experimental data collected under well-defined conditions. The STP model reproduces the exact solutions when both are based on consistent assumptions. Suggested approximated terms in the model also reproduce the experimental data nearly within its error under simple flow conditions. The STP model describes the origin of more complex behavior (counter-gradient diffusion, for example) and has the potential of describing it if sufficient detail about the gas-phase turbulence is known.

6345 (UCRL-JC–118604) **The parallel performance of a groundwater flow code on the Cray T3D.** Ashby, S.F.; Falgout, R.D.; Smith, S.G.; Thompson, A.F.B. Lawrence Livermore National Lab., CA (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950212–3: 7. SIAM conference on parallel processing for scientific computing, San Francisco, CA (United States), 15-17 Feb 1995). Order Number DE95002843. Source: OSTI; NTIS; GPO Dep.

This paper summarizes some preliminary results on the parallel performance of ParFlow, a new code for the numerical simulation of groundwater flow through three-dimensional heterogeneous porous media. At present, this code is capable of simulating groundwater flow for large sites (10^7 spatial zones) on a variety of distributed memory MIMD machines. The computational kernels are described briefly and their parallel performance is examined on the Cray T3D massively parallel computer using Cray's implementation of the PVM message-passing library.

6346 (WAPD-T–3063) **Vertical natural convection heat transfer data for an enclosed fluid.** Coffield, R.D.; Harry, J.A. Bettis Atomic Power Lab., West Mifflin, PA (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC11-93PN38195. (CONF-9409267–1: American Society of Mechanical Engineers fluids engineering summer meeting, Hilton Head, SC (United States), 13 Sep 1994 - 18 sep 1995). Order Number DE95003874. Source: OSTI; NTIS; GPO Dep.

Natural convection flow of enclosed fluids with high temperature gradients can result in extremely high heat transfer rates. This phenomenon must be accurately modeled in order to predict the correct temperature distribution of structures in contact with the convecting flow. Ignoring the heat transfer by natural convection and assuming only the normal molecular heat conduction of stagnant water can result in an underestimate of the heat transfer by several orders of magnitude. Natural convection of enclosed fluids is different than free convection to a non-enclosed (i.e., open) ambient atmosphere since the recirculating fluid flow pattern can have a significant influence on the resultant heat transfer. Rayleigh numbers extending the entire range from conditions where free convection is a second order effect (e.g., $Ra < 3000$) to those where turbulent free convection dominates (e.g., $Ra > 10^5$) were tested and the results described. Inconsistencies between earlier investigations reported in the literature are resolved because of the wide test range capability. Correlations of the data in the form of Nusselt number as a function of Rayleigh number are provided for $0 < Ra < 10^{12}$.

4205 Materials Testing

Refer also to citation(s) 5474, 5570, 5723, 5724, 5758, 5761, 5762, 5764, 5765, 5766, 5767, 5768, 5769, 5771, 5772, 5773, 5774, 5775, 5776, 5778, 5779, 5780, 5781, 5782, 5783, 5784, 5786, 5787, 5788, 5789, 5790, 5791, 5792, 5794, 5795, 5796, 5797, 5798, 5800, 5801, 5802, 5803, 5804, 5805, 5806, 5807, 5809, 5810, 5811, 5812, 6113, 6374

6347 (BNL–61087) **Inelastic neutron scattering for materials science and engineering.** Shapiro, S.M. Brookhaven National Lab., Upton, NY (United States). [1995]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95003954. Source: OSTI; NTIS; INIS; GPO Dep.

The neutron is the ideal probe for studying the positions and motions of atoms in condensed matter. The main advantage of the neutron in inelastic scattering results from its heavy mass when compared to other particles which are used to probe materials such as the photon (light, x-rays, or γ-rays) or the electron. The author discusses the application of neutron scattering to study a number of different materials related problems, including, hard magnets, shape memory effects, and hydrogen distribution in metals.

6348 (ETDE/DE-mf–95726883) **Annual report 1993 of the Federal Office for Material Research and Testing.** Bundesanstalt fuer Materialforschung und -pruefung, Berlin (Germany). Apr 1994. 264p. (In German). Order Number DE95726883. Source: OSTI; NTIS (US Sales Only).

The present volume reports on the activities of the Federal Office for Material Research and Testing and its departments Metals and Metal Constructions, Building Materials and Building Structures, Organic Substances, Chemical Safety Technology, Functional Materials and Surfaces, Material-Independent Processes, Scientific and Technical Cross-Sectional Tasks, Environment-Related Material Technologies, Technical Reliability/Hazardous Material Encapsulation and Analytic Chemistry/Reference Materials. The work of the project groups Computer Tomography, High-Performance Ceramics, Database for Hazardous Materials (DGG) and ADR Structural Reform is also briefly reported on. (MM)

6349 (FRCEA-TH–410) **Resolution improvement of ultrasonic echography methods in non destructive testing by adaptative deconvolution.** Vivet, L. CEA Centre d'Etudes de Cadarache, 13 - Saint-Paul-lez-Durance (France). Dept. d'Etudes des Combustibles; Paris-11 Univ., 91 - Orsay (France). 28 Sep

1989. 158p. (In French). Order Number DE95611124. Source: OSTI; NTIS (US Sales Only); INIS.

The ultrasonic echography has a lot of advantages which make it attractive for nondestructive testing. But the important acoustic energy useful to go through very attenuating materials can be got only with resonant translators, that is a limit for the resolution on measured echograms. This resolution can be improved by deconvolution. But this method is a problem for austenitic steel. Here is developed a method of time deconvolution which allows to take in account the characteristics of the wave. A first step of phase correction and a second step of spectral equalization which gives back the spectral contents of ideal reflectivity. The two steps use fast Kalman filters which reduce the cost of the method.

6350 (LA-UR–94-3806) **Prediction of material strength and fracture of brittle materials using the SPHINX smooth particle hydrodynamics code.** Mandell, D.A.; Wingate, C.A.; Stellingwwerf, R.F. Los Alamos National Lab., NM (United States). [1995]. 4p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9405265–1: ASCE engineering mechanics conference, Boulder, CO (United States), 21-24 May 1994). Order Number DE95003684. Source: OSTI; NTIS; GPO Dep.

The design of many devices involves numerical predictions of the material strength and fracture of brittle materials. The materials of interest include ceramics that are used in armor packages; glass that is used in windshields; and rock and concrete that are used in oil wells. As part of a program to develop advanced hydrocode design tools, the authors have implemented a brittle fracture model for glass into the SPHINX smooth particle hydrodynamics code. The authors have evaluated this model and the code by predicting data from tungsten rods impacting glass. Since fractured glass properties, which are needed in the model, are not available, they did sensitivity studies of these properties, as well as sensitivity studies to determine the number of particles needed in the calculations. The numerical results are in good agreement with the data.

6351 (LA-UR–94-4014) **Algorithm for dual-energy radiographic analysis.** Morris, R.A.; Chancellor, T. Los Alamos National Lab., NM (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9407123–4: 1994 review of progress in quantitative nondestructive evaluation conference, Snowmass, CO (United States), 31 Jul - 5 aug 1994). Order Number DE95003675. Source: OSTI; NTIS; GPC Dep.

The use of two or more radiographs of an object taken with different x-ray spectral characteristics to infer quantitative values of material density or Z number has been of interest to both the medical and industrial worlds for some time. One method uses monoenergetic isotopic sources with well defined energies in conjunction with standard step wedges and solving the resulting simultaneous equations. Besides the problem of finding isotopic sources with the appropriate energies, you have to have a priori knowledge of the materials in the object. This paper describes an algorithm that does not impose any limitations on the energy spectrum of the sources nor require any knowledge of the object. The algorithm does require that the different radiographs have perfect spatial registration (within a pixel width) and assumes that the transmitted x-ray intensity spectra is the same (within a multiplicative constant) over the image plane. This paper is just a start in developing multi-energy techniques; objects with three or more materials have not been investigated and it is not clear just how this algorithm should be generalized to the multi-energy case.

6352 (LA-UR–94-4082) **What can we learn from off-specular neutron reflection?.** Pynn, R. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–5: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003635. Source: OSTI; NTIS; INIS; GPO Dep.

Specular reflection of neutrons or x rays has been developed recently as a tool to probe density variations in the neighborhood of flat interfaces. The techniques have been applied to a variety of materials problems ranging from polymer adsorption to hydrogenation of carbon films and the structure of magnetic multilayers. In addition to the specular scattering, diffuse scattering is often observed, sometimes in strikingly beautiful patterns. This scattering is caused by imperfections such as interfacial roughness or density fluctuations within a layer. As a general rule, the diffuse, off-specular scattering measures the density-density correlation function within and between the interfaces responsible for the specular scattering. Interpretation of diffuse x-ray and neutron scattering from surfaces and interfaces is in its infancy using theoretical schemes that are still being developed. In this talk the author shows examples of diffuse scattering patterns and offers some guidelines for their interpretation.

6353 (UCRL-ID–112775, pp. 6.11-6.15) **Characterizing the failure of composite materials.** Groves, S.E.; Sanchez, R.J.; Feng, W.W.; Brown, A.E.; DeTeresa, S.J.; Lyon, R.E. Lawrence Livermore National Lab., CA (United States). Mar 1993. In *Materials Science and Engineering.* 30p. Order Number DE94003018. Source: OSTI; NTIS; GPO Dep.

The goal for this project has been to characterize the three-dimensional (3-D) performance of continuous-fiber polymer composite materials, by developing new experimental and theoretical methods. This report highlights our major accomplishments: (1) multiaxial testing of composites; (2) the development of a new composite-failure criterion; (3) the development of ORTHO3D, a 3-D orthotropic finite element code; (4) the dynamic testing of composites; and (5) a helical compression study of filament-wound composite tubes. 6 refs., 8 figs., 1 tab.

4210 Combustion Systems

Refer also to citation(s) 4989

6354 (DOE/PC/94110–T1) **Commercial and industrial boiler modification program for improved efficiencies. Technical progress report No. 1, April 1994–June 1994.** TECOGEN, Inc., Waltham, MA (United States). 28 Sep 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC22-94PC94110. Order Number DE95004314. Source: OSTI; NTIS; GPO Dep.

During the first reporting period, the design of the system modifications was initiated. The system engineering work was completed and significant progress was made in completing the detailed designs. The design shows that a system efficiency of 86.69 percent based on the higher heating value is possible. Obtaining this efficiency provides the project with its first design success. During the next reporting period, the design will be continued and completed.

6355 (SAND–94-8556) **User guide to the Burner Engineering Research Laboratory.** Fornaciari, N. (Sandia National Lab., Livermore, CA (United States)); Schefer, R.; Paul, P.; Lubeck, C.; Sanford, R.; Claytor, L. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 27p. Sponsored by USDOE, Washington, DC (United States);Gas Research Inst., Chicago, IL (United States). DOE Contract AC04-94AL85000. (CONF-9410193–1: International conference on environmental control of combustion processes, Honolulu, HI (United States), 7-10 Oct 1994). Order Number DE95004191. Source: OSTI; NTIS; GPO Dep.

The Burner Engineering Research Laboratory (BERL) was established with the purpose of providing a facility where manufacturers and researchers can study industrial natural gas burners using conventional and laser-based diagnostics. To achieve this goal, an octagonal furnace enclosure with variable boundary conditions and optical access that can accommodate burners with firing rates up to 2.5 MMBtu per hour was built. In addition to conventional diagnostic capabilities like input/output measurements, exhaust gas monitoring, suction pyrometry and in-furnace gas sampling, laser-based diagnostics available at BERL include planar Mie scattering, laser Doppler velocimetry and laser-induced fluorescence. This paper gives an overview of the operation of BERL and a description of the diagnostic capabilities and an estimate of the time required to complete each diagnostic for the potential user who is considering submitting a proposal.

4220 Mining and Underground Engineering

Refer also to citation(s) 6458, 6460, 6461, 6465

6356 (CONF-9405258–, pp. 320-324) **Three-dimensional magnetic induced polarization (MIP) modeling.** Hishida, H. (Metal Mining Agency of Japan, Tokyo (Japan)); Noguchi, K. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports the interpretation, by three-dimensional model calculation, of the result of an MIP survey on the HYC silver-lead-zinc deposit, McArthur River area, Australia. In case where the current dipole is oriented from north to south (as the deposit strikes) for the above survey, strong anomaly in RPS (index of anomaly in IP) appears in the vicinity of western deposit end. However, considerable anomaly does not appear in case of east-west orientation. Based on the geological information and physical property measurement result of borehole cores, modeled is an IP anomalous body composed of four rectangular parallelopiped blocks which respectively have a north-south length of 800m and vertical section of 100m by 100m, and are arrayed with their laterally touching each other and so buried as to eastward form a downward inclination of about 20° starting slightly below the surface. Assuming that the resistivity of the above body and surrounding medium is 10ohm m and 100ohm m, respectively, the RPS distribution is obtained by a three-dimensional model calculation with solution of integral equation. It is shown that the RPS thus obtained agrees well with that done from the MIP survey. 9 refs., 6 figs.

6357 (CONF-9405258–, pp. 460-463) **Fundamental study for prospecting of inclined small jacking pipe by electromagnetic method.** Kusumi, H. (Kansai University, Osaka (Japan). Faculty of Engineering); Nishida, K.; Tanaka, H.; Kagami, K. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The excavation with a small diameter propelling tube inclined to the horizontal plane was fundamentally investigated using a miniature model of 1/10 size of the tube. The induction voltage generated in the receiving coil which was placed on the ground surface was measured when the AC was passed through the circular coil attached to the tip of the small diameter tube. The inclination (to the horizontal plane) of the receiving coil, which exhibited the minimum induction voltage, were measured at several points across the center axis of the predicted propelling tube, to obtain the depth of the tube axis from the ground surface. The similar measurement was also done at several points on the ground surface measurement line along the propelling tube. In the case of PVC tube, it was found that the inclination angle could be measured accurately when the depth of the tube tip was about 20 times of the radius of the transmitting coil. In the case of steel tube, on the other hand, it was found that the steel tube effect could be reduced by attaching the transmitting coil outside the tube rather than attaching it inside the tube. 2 refs., 8 figs.

4230 Marine Engineering

6358 (NEI-NO–465) **Studies of weak and strong nonlinear sea loads on floating marine structures.** Zhao Rong. Trondheim Univ. (Norway). Norges Tekniske Hoegskole. Apr 1994. 98p. Order Number DE95723941. Source: OSTI; NTIS.

This thesis consists of four selected papers of my work for the paste few years, which considers some problems of weak and strong nonlinear sea loads on floating marine structures. The weak nonlinear problem that we study here, is hydrodynamic loads on marine structures due to wave-current-body interaction. The strong nonlinear problem that we consider, is slamming loads on conventional and high-speed vessels. The first two papers deal with the wave-current-body interaction problem. A theoretical and numerical method to analyse wave-current interaction effects on large-volume structure is developed. The theory is based on matching a local solution to a far-field solution. In the far-field the waves "ride" on the undisturbed current velocity, while in the near-field the waves "ride" on the local steady flow. A boundary element method based on Green's second identity has been applied to solve the problem. The far-field solution is represented by a sum of multipoles with singularities inside the body. The multipoles satisfy the radiation condition and the far-field free-surface condition. The problem has been solved to first-order in incident wave amplitude and current velocity. In the free-surface conditions and body boundary conditions the local steady flow has been taken care of. The last two papers consider the slamming loads on marine structures. A numerical method for studying water entry of a two-dimensional body of arbitrary rigid cross-section is presented. A boundary element method has been used to solve the problem with nonlinear free-surface and body boundary conditions. Important features are how the jet flows occurring at the intersections between the free-surface and the body are handled, and how conservation of fluid mass is satisfied in areas of high curvature of the free-surface. The numerical results have been checked by satisfying conservation of mass, momentum and energy. 103 refs., 45 figs., 5 tabs.

4260 Components, Electron Devices and Circuits

Refer also to citation(s) 5737, 5990, 6178, 6252, 6253, 6407, 6450, 6817

6359 (CRIE-R–01) **Study on propagation impairments, distortions and unavailability on digital microwave links.** Serizawa, Y. (Central Research Institute of Electric Power Industry, Tokyo (Japan)). Central Research Inst. of Electric Power Industry, Tokyo (Japan). Dec 1993. 153p. (In Japanese). Order Number DE95723047. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-5-1, Ote-machi, Chiyoda-ku, Tokyo, Japan.

A study was made on propagation impairments (degradation) and distortions for design, route layout and operation of digital microwave links for information network basic telecommunication. As to multipath interference fading which causes distortions, a method to predict an outage probability of the link was introduced from in-band amplitude deviation. In the case of having system gains by influence of man-made structures, that is, in the case of the link in which the reflector is installed in the Fresnel region, in the reflector relay link, a precise measuring method to gain reflector was introduced. With the equivalent C/N degradation amount, a method was developed for estimation of influence quantity in the case of system loss (propagation impairments) caused by structures standing in the propagation path, and unnecessary reflection/scattered wave. With relation to CPM current differential teleprotection systems, a theoretical study was made on a relation between error ratio characteristics and relay motion at fading, indicating that the required bit error ratio is approximately 10^{-6} - 10^{-7}. 94 refs., 91 figs., 12 tabs.

6360 (DOE/CH/10093–298) **Smart Power/power integrated circuits, technology and applications: Proceedings.** National Renewable Energy Lab., Golden, CO (United States). Mar 1994. 359p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC36-83CH10093. (CONF-931274–: 2. workshop on smart power/power-integrated circuits: technology and applications, Pasadena, CA (United States), 8-9 Dec 1993). Order Number DE94006867. Source: OSTI; NTIS; GPO Dep.

Individual papers are indexed.

6361 (KCP–613-5515) **Piezoelectric motor development at AlliedSignal Inc., Kansas City Division.** Pressly, R.B.; Mentesana, C.P. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Nov 1994. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. (CONF-9411151–1: Technology 2004, Washington, DC (United

States), 8-10 Nov 1994). Order Number DE95003389. Source: OSTI; NTIS; GPO Dep.

The Kansas City Division of AlliedSignal Inc. has been investigating the fabrication and use of piezoelectric motors in mechanisms for United States Department of Energy (DOE) weapons applications for about four years. These motors exhibit advantages over solenoids and other electromagnetic actuators. Prototype processes have been developed for complete fabrication of motors from stock materials, including abrasive machining of piezoelectric ceramics and more traditional machining of other motor components, electrode plating and sputtering, electric poling, cleaning, bonding and assembly. Drive circuits have been fabricated and motor controls are being developed. Laboratory facilities have been established for electrical/mechanical testing and evaluation of piezo materials and completed motors. Recent project efforts have focused on the potential of piezoelectric devices for commercial and industrial use. A broad range of various motor types and application areas has been identified, primarily in Japan. The Japanese have been developing piezo motors for many years and have more recently begun commercialization. Piezoelectric motor and actuator technology is emerging in the United States and quickly gaining in commercial interest. The Kansas City Division is continuing development of piezoelectric motors and actuators for defense applications while supporting and participating in the commercialization of piezoelectric devices with private industry through various technology transfer and cooperative development initiatives.

6362 (LA-UR–94-3985) **Advanced technologies for a compact rf linac FEL.** Nguyen, D.C. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9408196–1: FEL '94: nuclear instrument methods, Stanford, CA (United States), 21-26 Aug 1994). Order Number DE95003674. Source: OSTI; NTIS; INIS; GPO Dep.

Advanced technologies such as the photoinjector, the short-period microwigglers, and harmonic lasing enable free-electron-laser operation in the infrared with a low-energy (~ 10 MeV) electron beam and thus reduce the size and cost of FELs. The next-generation, rf-linac FEL will fit in a small laboratory and produce high-power, picosecond infrared.

6363 (SAND–94-1112C) **Assessing capillary flow on printed wiring board surfaces.** Hosking, F.M.; Yost, F.G.; Hernandez, C.L.; Sackinger, S.J. Sandia National Labs., Albuquerque, NM (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950344–1: InterPack '95: international electronic packaging conference, Maui, HI (United States), 26-30 Mar 1995). Order Number DE94015768. Source: OSTI; NTIS; GPO Dep.

A solderability test for evaluating capillary flow on printed wiring boards is presented. The test measures the flow of molten solder from a pad of fixed diameter onto attached strips of different widths. The technique simulates capillary flow behavior, including wetting kinetics, during typical electronics soldering. A flow model is proposed. Computational and experimental data are compared.

6364 (SAND–94-1982C) **Using consumer IC packages in harsh high reliability applications.** Reber, C.A.; Palmer, D.W. Sandia National Labs., Albuquerque, NM (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950344–2: InterPack '95: international electronic packaging conference, Maui, HI (United States), 26-30 Mar 1995). Order Number DE94016565. Source: OSTI; NTIS; GPO Dep.

The improvements in purity of molding materials, the IC wafer passivation layers, and manufacturing quality have resulted over the last decade in extremely high reliability in commercial IC packages. In contrast the ceramic/hermetic package world is suffering from limited availability of the newest IC chips, higher cost, larger size, and decreasing quality and fewer manufacturing lines. Traditional manufacturing line qualification tests are a good start for conversion to commercial plastic parts. However, the use of standard sensitive test chips instead of product die is necessary to perform affordable, quantitative evaluations. These test chips have many integrated sensors measuring chemical, mechanical, thermal, and electrical degradation caused by manufacturing and the package environment. Besides visual, electrical test, and burn-in little has been documented on 100% nondestructive screening of plastic molded parts. Based on realistic process control and system engineer cultural expectations, user screening is necessary. Nondestructive tests of moisture and temperature excursion susceptibility are described.

6365 (SAND–94-2749C) **Solderability preservation through the use of organic inhibitors.** Sorensen, N.R.; Hosking, F.M. Sandia National Labs., Albuquerque, NM (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950344–4: InterPack '95: international electronic packaging conference, Maui, HI (United States), 26-30 Mar 1995). Order Number DE95003633. Source: OSTI; NTIS; GPO Dep.

Organic inhibitors can be used to prevent corrosion of metals and have application in the electronics industry as solderability preservatives. We have developed a model to describe the action of two inhibitors (benzotriazole and imidazole) during the environmental aging and soldering process. The inhibitors bond with the metal surface and form a barrier that prevents or retards oxidation. At soldering temperatures, the metal-organic complex breaks down leaving an oxide-free metal surface that allows excellent wetting by molten solder. The presence of the inhibitor retards the wetting rate relative to clean copper, but provides a vast improvement relative to oxidized copper.

6366 (UCRL-JC–117859) **Low-cost packaging of high-performance optoelectronic components.** Lowry, M.; Lu, Shin-Yee; Pocha, M.; Strand, O.T. Lawrence Livermore National Lab., CA (United States). Aug 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940723–34: Annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 24-29 Jul 1994). Order Number DE95003645. Source: OSTI; NTIS; GPO Dep.

Optoelectronic component costs are often dominated by the costs of attaching fiber optic pigtails–especially for the case of single transverse mode devices. We present early results of our program in low-cost packaging. We are employing machine-vision controlled automated positioning and silicon microbench technology to reduce the costs of optoelectronic components. Our machine vision approach to automated positioning has already attained a positional accuracy of less than 5 microns in less than 5 minutes; accuracies and times are expected to improve significantly as the development progresses. Complementing the machine vision assembly is our manufacturable approach to silicon microbench technology. We will describe our silicon microbench optoelectronic device packages that incorporate built-in heaters for solder bonding reflow.

43 PARTICLE ACCELERATORS

4301 Design, Development, and Operation

Refer also to citation(s) 5493, 5494, 5497, 5505, 6362, 6594, 6662, 6933

6367 (BNL–60963) **A report on the Indiana University Workshop on future U.S. hadron facilities.** Syphers, M.J. Brookhaven National Lab., Upton, NY (United States). [1995]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9411120–2: 4. Tamura symposium on accelerator physics, Austin, TX (United States), 14-16 Nov 1994). Order Number DE95003951. Source: OSTI; NTIS; INIS; GPO Dep.

In July 1994 a workshop was held at Indiana University to study and discuss options for future hadron collider facilities in the United States, and to identify related R&D programs. The workshop was conducted under the auspices of the Accelerator Physics, Technologies, and Facilities Working Group of the DPF Long Term Planning Study. Roughly 50 participants from 17 institutions in the U.S. and Europe (CERN) were organized into six working groups to study magnets, cryogenics and vacuum, antiproton sources,

injectors, interaction regions, and lattice and beam dynamics. Upgrades to existing facilities (namely, Fermilab) and a post-LHC facility were discussed at the workshop. In this paper, the discussion will focus on the post-LHC facility. One of the specific goals of the workshop was to develop a defensible parameters list for a 30 TeV x 30 TeV hadron collider with luminosity of 1×10^{34} cm^{-2} sec^{-1}. While this accelerator would have only 50% higher energy than the SSC design, it was realized that the role of synchrotron radiation at this energy would significantly enhance the design and operation of the machine. Radiation damping times of a few hours, rather than one day, can be realized thus allowing less intense, but brighter proton beams.

6368 (DOE/ET/53088–683) **Envelope evolution of a laser pulse in an active medium.** Fisher, D.L.; Tajima, T.; Downer, M.C.; Siders, C.W. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Nov 1994. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. (IFSR–683). Order Number DE95004402. Source: OSTI; NTIS; INIS; GPO Dep.

The authors show that the envelope velocity, v_{env}, of a short laser pulse can, via propagation in an active medium, be made less than, equal to, or even greater than c, the vacuum phase velocity of light. Simulation results, based on moving frame propagation equations coupling the laser pulse, active medium and plasma, are presented, as well as equations that determines the design value of super- and sub-luminous v_{env}. In this simulation the laser pulse evolves in time in a moving frame as opposed to their earlier work where the profile was fixed. The elimination of phase slippage and pump depletion effects in the laser wakefield accelerator is discussed as a particular application. Finally they discuss media properties necessary for an experimental realization of this technique.

6369 (FNAL/C–94/360) **Fermilab Tevatron and upgrade status.** Holmes, S.D.; Yarba, V.A. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9410258–1: 14. conference on charged particle accelerators, Protvino (Russian Federation), 25-27 Oct 1994). Order Number DE95003501. Source: OSTI; NTIS; INIS; GPO Dep.

Performance and performance limitations of the Tevatron proton-antiproton collider at Fermilab will be discussed along with plans for improving the performance by a factor of five by the end of the decade. The centerpiece of this effort is the Fermilab Main Injector, a new 150 GeV synchrotron now under construction. Status of the project will be presented.

6370 (FNAL-TM–1907) **Proceedings of the workshop on future hadron facilities in the US.** Fermi National Accelerator Lab., Batavia, IL (United States); Universities Research Association, Batavia, IL (United States). [1994]. 140p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9407128–Summs.: Workshop on future hadron facilities in the United States, Bloomington, IN (United States), 6-10 Jul 1994). Order Number DE95004513. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics on future hadron facilities: Workshop on future hadron facilities in the US; 30 x 30 TeV-summary report; A high luminosity, 2 x 2 TeV collider in the tevatron tunnel; magnets working group; cryogenics discussion; vacuum report; antiproton source production; injector working group; interaction region working group; lattice/beam dynamics working group; LEBT for high-luminosity colliders; some notes on long-range beam-beam effects for the 2TeV collider; synchrotron radiation masks for high energy proton accelerators. Emittance preservation in a proton synchrotron; beam-beam interaction effects on betatron tunes; analytic solutions for phase trombone modules; and chromatic corrections of RHIC when one or two insertions is at $B^* = 0.5m$.

6371 (FNAL-TM–1909) **Introduction to colliding beams at Fermilab.** Thompson, J. (Univ. of Maryland, College Park, MD (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE95003387. Source: OSTI; NTIS; INIS; GPO Dep.

The Fermi National Accelerator Laboratory is currently the site of the world's highest center-of-mass energy proton-antiproton colliding beam accelerator, the Tevatron. The CDF and Dv detectors each envelop one of two luminous regions in the collider, and are thus wholly dependent on the accelerator for their success. The Tevatron's high operating energy, reliability, and record setting integrated luminosity have allowed both experiments to make world-class measurements and defined the region of physics that each can explore. The following sections are an overview of the highlights of the accelerator operation and are compiled from many sources. The major sources for each section are listed at the beginning of that section.

6372 (INIS-mf–14420(Pt.1.2.3), [pp. 8]) **Development of the next generation of powerful electron accelerators.** Kuksanov, N.K. (AN SSSR, Novosibirsk (Russian Federation). Inst. Yadernoj Fiziki); Korabelnikov, B.M.; Kosilov, M.R.; Prudnikov, V.V.; Salimov, R.A. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.1.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

Technical and exploitation parameters of powerful electron accelerators of new generation constructed in Budker Institute of Nuclear Physics SB RAS in Novosibirsk have been shown. Two types (200 kW and 500 kW) of such accelerators designated especially for industrial applications have been presented. 4 figs.

6373 (INIS-mf–14420(Pt.1.2.3), [pp. 9]) **Overview of Nissin high voltage's e-beam technologies.** Sakamoto, I. (Nissin - High Voltage Co. Ltd., Kyoto (Japan)); Mizusawa, K.; Taniguchi, S.; Hoshi, Y. International Atomic Energy Agency, Vienna (Austria); Institute of Nuclear Chemistry and Technology, Warsaw (Poland). [1994]. [240p.] (CONF-9305397–: IAEA final research co-ordination meeting on radiation processing of combustion flue gases, Zakopane (Poland), 24-28 May 1993). In *IAEA final research co-ordination meeting on radiation processing of combustion flue gases. Poland, Zakopane, 24-28 May, 1993. Pt.1.* Order Number DE95610863. Source: OSTI; NTIS; INIS.

The Nissin-High Voltage Co. Ltd. was establishes more than two decades ago as a specialized manufacturer of electron beam accelerators and has been engaged in the development of e-beam accelerators designed to melt a wide variety of customers of industrial and environmental applications. The current status of e-beam technologies at Nissin-High Voltage Co. Ltd. has been described and discussed as well as specific requirements for e-beam systems used for flue gas treatment have been presented.

6374 (INIS-mf–14422) **Accelerator facilities users' guide.** Walter, H.C. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Adrion, L.; Frosch, R.; Salzmann, M. (eds.). No corporate text available. Jul 1994. 106p. Order Number DE95611104. Source: OSTI; NTIS (US Sales Only); INIS.

In 1981 the "Green Book" of SIN was distributed, a User Handbook serving the needs of people already working at SIN as well as informing new users about our installations. An update of the Green Book is necessary because many beams have disappeared, been modified or added, and the installation has been upgraded in intensity and versatility quite considerably. The spectrum of users has shifted away from nuclear and particle physics; applications in medicine, solid state physics and materials science have gained in importance. This Users' Guide is intended to inform our users about the changes, and to interest potential new users in coming to PSI. (author) figs., tabs.

6375 (LA-UR–94-3785) **A debris free, electron beam driven, lithography source at 130 Å.** Fulton, R.D.; Abdallah, J.; Goldstein, J.C.; Jones, M.E.; Kilcrease, D.P.; Kinross-Wright, J.M.; Kong, S.H.; Nguyen, D.C. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC

(United States). DOE Contract W-7405-ENG-36. (CONF-9409177–6: Optical Society of America conference on extreme ultraviolet lithography, Monterey, CA (United States), 19-21 Sep 1994). Order Number DE95003687. Source: OSTI; NTIS; INIS; GPO Dep.

Los Alamos and Grumman are cooperatively investigating a debris free source for EUV lithography. This source utilizes the predicted anomalous energy loss of a short pulse electron beam in a preformed plasma to heat and ionize the ions to a charge state where efficient radiation at 130Å occurs. Accelerators developed for the free electron laser program at Los Alamos are used as the electron bunch source. These accelerators use a laser driven photocathode to produce 15 psec electron bunches containing 4 nC of charge with an energy of 15.5 MeV. These micropulses are produced at a repetition rate of 108 MHz and continue for the length of the rf macropulse energizing the accelerator cavities, typically 1–10 μsec. The weakly ionized preformed plasma is created by purely classical collisional ionization caused by the initial few electron micropulses within the macropulse. When a critical electron density is reached, $n_e \simeq 1.6 \times 10^{15}/\tau^2$ cm^{-3}, where τ is the FWHM, in psec, of the electron bunch, the plasma responds collectively to the electron micropulse generating a large amplitude plasma wave. The plasma wave efficiently slows the high energy electron beam while heating the background plasma electrons. The initial electron population rapidly heats and then equilibrates with the bulk ion and electron populations in a few 10's of picoseconds. With neon as the dominant ionic species, an efficient filamentary radiator of line radiation near 130Å is created. A proof-of-principle experiment has been completed to demonstrate the anomalous energy loss process and bench-mark theoretical calculations at much lower densities appropriate to the existing 15 psec electron bunches.

6376 (LA-UR–94-3974) **Development of a RAMI model for LANSCE and high power APT accelerators.** Tallerico, P.J. Los Alamos National Lab., NM (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9410218–5: Pulsed radio frequency sources for linear colliders, Long Island, NY (United States), 2-7 Oct 1994). Order Number DE95003670. Source: OSTI; NTIS; INIS; GPO Dep.

Assessment of the reliability, availability, maintainability and inspectability (RAMI) of all high power, high cost systems is important to justify and improve the cost effectiveness of these systems. For the very large (over 100 MW) accelerator systems associated with APT, a RAMI model is very valuable in guiding the design and allocation of resources. A RAMI model of an existing machine is also valuable, since machine improvement funds must be allocated to increase the availability by the largest amount. The authors have developed a RAMI model using the critical subsystems of the LANSCE accelerator and beam delivery complex as an example and to evaluate the effectiveness for estimating reliability and beam availability. LAMPF and LANSCE together provide most of the features required for the accelerator and beam delivery part of a high-power APT machine, but LANSCE is pulsed, rather than CW. This complex is capable of a 1-MW average power H^- beam, and it is the most powerful proton accelerator in the US built to date.

6377 (LBL–35533) **Post-accelerator issues at the IsoSpin Laboratory.** Chattopadhyay, S.; Nitschke, J.M. (eds.). Lawrence Berkeley Lab., CA (United States). May 1994. 198p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9310290–: Workshop on postacceleration issues at the IsoSpin Laboratory (ISL), Berkeley, CA (United States), 27-29 Oct 1993; CBP–075). Order Number DE95003417. Source: OSTI; NTIS; INIS; GPO Dep.

The workshop on "Post-Accelerator Issues at the Isospin Laboratory" was held at the Lawrence Berkeley Laboratory from October 27–29, 1993. It was sponsored by the Center for Beam Physics in the Accelerator and Fusion Research Division and the ISL Studies Group in the Nuclear Science Division. About forty scientists from around the world participated vigorously in this two and a half day workshop, (c.f. Agenda, Appendix D). Following various invited review talks from leading practitioners in the field on the first day, the workshop focussed around two working groups: (1) the Ion Source and Separators working group and (2) the Radio Frequency Quadrupoles and Linacs working group. The workshop closed with the two working groups summarizing and outlining the tasks for the future. This report documents the proceedings of the workshop and includes the invited review talks, the two summary talks from the working groups and individual contributions from the participants. It is a complete assemblage of state-of-the-art thinking on ion sources, low-β, low(q/A) accelerating structures, e.g. linacs and RFQS, isobar separators, phase-space matching, cyclotrons, etc., as relevant to radioactive beam facilities and the IsoSpin Laboratory. We regret to say that while the fascinating topic of superconducting low-velocity accelerator structure was covered by Dr. K. Shepard during the workshop, we can only reproduce the copies of the transparencies of his talk in the Appendix, since no written manuscript was available at the time of publication of this report. The individual report have been catologed separately elsewhere.

6378 (LBL-PUB–601) **Advanced Light Source report. Volume 7, No. 1.** Lawrence Berkeley Lab., CA (United States). Sep 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95003449. Source: OSTI; NTIS; GPO Dep.

The exceptional science already emerging from the user program at the ALS shows that the promises of "unique research opportunities" and "experiments not possible anywhere else" made at the inception of the ALS are indeed coming true. In less than a year of beamline operations, the ALS has produced numerous high-quality results and achieved an enviable level of performance. Since the beginning of 1994, the ALS has operated for 92% of its scheduled hours, an outstanding achievement for a new machine. The ALS' ability to deliver the brightest light in the world in the ultraviolet and soft x-ray regions of the spectrum has attracted a who's who of synchrotron research to the experiment floor. These users have produced a variety of scientifically significant results during the ALS' first year of operation, a few of which are highlighted in this article.

6379 (SLAC-PUB–6650) **Accelerator modeling system for the future.** Lee, M. (Stanford Linear Accelerator Center, Menlo Park, CA (United States)); Cai, Y.; Tran, P. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Dec 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9409258–2: Workshop on nonlinear dynamics in particle accelerators: theory and experiments, Arcidosso (Italy), 4-9 Sep 1994). Order Number DE95004284. Source: OSTI; NTIS; INIS; GPO Dep.

Many computer programs and a variety of models exist for the design of accelerator lattices and the correction of errors. Many physicists contributed to this work by developing codes to suit a variety of machines. At present, we are integrating some of these codes into a unified framework to design and control any type of machine. We will refer to this system of interactive accelerator design, control, and analysis codes as the All-In-One Modeling system (AIM). This paper will explore the utilities of AIM for future accelerator modeling and control. As an example, we will describe a procedure to produce both a linear and a nonlinear model for SPEAR.

4302 Beam Dynamics, Field Calculations, and Ion Optics

6380 (FNAL/C–94/356-E) **Neutrino optics.** Carey, D.C. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9410229–2: 4. international conference on charged particle optics, Tsukuba (Japan), 3-6 Oct 1994). Order Number DE95004236. Source: OSTI; NTIS; INIS; GPO Dep.

Neutrinos are produced by the in-flight decay of π and k mesons. Neutrinos are uncharged and cannot be focused directly. However, the transverse momentum of the neutrino due to the decay is typically much smaller than the transverse momentum spread of the parent meson. The focusing of the meson beam will then significantly enhance the neutrino flux at a distant detector. Neutrino beams can effectively be focused in the same manner as other charged particle beams, by means of quadrupoles and bending magnets. The bending magnets also can serve to define the momentum of the neutrino beams. Alternatively, neutrino beams can be focused by the use of magnetic horns. Both systems are

described here. Proposed experiments with neutrinos to detect neutrino oscillations place the detector hundreds of kilometers away from the source. The flux of neutrinos through the detector then becomes very small. The calculation of the flux by conventional Monte Carlo or numerical integration techniques becomes prohibitively difficult. An alternate mathematical technique can be used to give results which are reliable to about 10%.

6381 (KEK-PROC–93-10, pp. 288-291) **Spectral analysis of electromagnetic field created by electron beam in the cylindrical waveguide.** Itoh, Hiroyasu (Hokkaido Univ., Sapporo (Japan). Faculty of Engineering); Tomioka, Satoshi; Enoto, Takeaki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

To examine the spectrum of the electromagnetic field created by micro-pulses of electron beams, we placed two reflective conductive plates in a cylindrical waveguide. We measured the spatial distributions of the resulting standing wave. Also we analyses the same configuration and obtains the spatial distributions. Furthermore we compared these two spectra in the frequency domain. (author).

6382 (KEK-PROC–93-10, pp. 292-295) **Exact solution of the transverse equation of motion for multibunched-beam dynamics.** Ogawa, Yujiro (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

An exact solution of the transverse equation of motion for multibunched-beam dynamics which is based on the rigid macroparticle model was obtained in a general form, where the betatron wave number and the beam energy both depend on position, i.e. the independent variable of the equation, in a certain manner. The result was compared with the numerical simulation to check its validity. By using this analytical solution, we might get better understanding of transverse wake-field effects in the case of high-current beam acceleration. (author).

6383 (SLAC-PUB–6727) **A fast tracking method using resonance basis Hamiltonians.** Irwin, J.; Chen, T.; Yan, Y.T. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Dec 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9409258–1: Workshop on nonlinear dynamics in particle accelerators: theory and experiments, Arcidosso (Italy), 4-9 Sep 1994). Order Number DE95004292. Source: OSTI; NTIS; INIS; GPO Dep.

A resonance basis map is an important way of analyzing lattice properties in circular accelerators. A method is developed to do tracking with resonance basis maps. The speed of this method is faster than other map tracking methods, and can be dramatically increased by dropping insignificant resonance terms. This mapping method enables us to simulate and study the interplay between lattice nonlinearities and other effects such as the beam-beam interaction.

4303 Auxiliaries and Components

Refer also to citation(s) 6377, 6418, 6419, 6420, 6421, 6422, 6423, 6424, 6429, 6440, 6441, 6442, 6444, 6446, 6447, 6448, 6678

6384 (ANL/APS/TM–12) **1993 CAT workshop on beamline optical designs.** Argonne National Lab., IL (United States). Nov 1993. 298p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31-109-ENG-38. (CONF-9307210–: 1993 CAT (Collaborative Access Team) workshop on beamline optical designs, Argonne, IL (United States), 26-27 Jul 1993). Order Number DE95004184. Source: OSTI; NTIS; INIS; GPO Dep.

An Advanced Photon Source (APS) Collaborative Access Team (CAT) Workshop on Beamline Optical Designs was held at Argonne National Laboratory on July 26–27, 1993. The goal of this workshop was to bring together experts from various synchrotron sources to provide status reports on crystal, reflecting, and polarizing optics as a baseline for discussions of issues facing optical designers for CAT beamlines at the APS. Speakers from the European Synchrotron Radiation Facility (ESRF), the University of Chicago, the National Synchrotron Light Source, and the University of Manchester (England) described single- and double-crystal monochromators, mirrors, glass capillaries, and polarizing optics. Following these presentations, the 90 participants divided into three working groups: Crystal Optics Design, Reflecting Optics, and Optics for Polarization Studies. This volume contains copies of the presentation materials from all speakers, summaries of the three working groups, and a "catalog" of various monochromator designs.

6385 (ANL/IPNS/CP–84859) **IPNS neutron scattering instrumentation: A – Existing and planned; B – Possibilities for IPNS upgrade, a 1-MW spallation source.** Brown, B.; Crawford, K. Argonne National Lab., IL (United States). Intense Pulsed Neutron Source (IPNS) Program. [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-941144–17: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95004119. Source: OSTI; NTIS; INIS; GPO Dep.

The Intense Pulsed Neutron Source (IPNS) is a pulsed spallation neutron source located at Argonne National Laboratory near Chicago, Illinois in the US. This facility is the outgrowth of a long line of pioneering work on pulsed spallation neutron sources begun at Argonne in the early 1970s. IPNS uses protons accelerated in the Rapid Cycling Synchrotron to produce neutrons via the spallation process (effectively a nuclear evaporation in which 10–50 neutrons are released per incident proton) in a heavy-element target. These neutrons are then moderated to produce spectra peaked at thermal or subthermal energies, and directed into beams which serve a variety of instruments. This paper discusses the diffractometers, various spectrometers, and reflectometers in existence and those planned for the upgrade of the IPNS.

6386 (FNAL/C–94/333) **Charged particle beam current monitoring tutorial.** Webber, R.C. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9410219–21: Beam instrumentation workshop, Vancouver (Canada), 2-6 Oct 1994). Order Number DE95003379. Source: OSTI; NTIS; INIS; GPO Dep.

A tutorial presentation is made on topics related to the measurement of charged particle beam currents. The fundamental physics of electricity and magnetism pertinent to the problem is reviewed. The physics is presented with a stress on its interpretation from an electrical circuit theory point of view. The operation of devices including video pulse current transformers, direct current transformers, and gigahertz bandwidth wall current style transformers is described. Design examples are given for each of these types of devices. Sensitivity, frequency response, and physical environment are typical parameters which influence the design of these instruments in any particular application. Practical engineering considerations, potential pitfalls, and performance limitations are discussed.

6387 (FNAL/C–94/399) **Electron drift velocities of Ar-CO_2-CF_4 gas mixtures.** Markeloff, R. (Northern Illinois Univ., DeKalb, IL (United States). Dept. of Physics); Haggerty, H.; Shao, Y. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-941061–11: Nuclear science symposium: medical imaging conference, Norfolk, VA (United States), 30 Oct - 5 nov 1994). Order Number DE95004353. Source: OSTI; NTIS; INIS; GPO Dep.

The muon spectrometer for the D0 experiment at Fermi National Accelerator Laboratory uses proportional drift tubes filled with an Ar-CO_2-CF_4 gas mixture. Measurements of drift velocity as a function of electric field magnitude for 90%-5%-5% and 90%-4%-6% Ar-CO_2-CF_4 mixtures are presented, and our operational experiences with these gases at D0 is discussed.

6388 (FNAL-TM–1908) **A longitudinal bunch monitoring system using LabVIEW® and high-speed oscilloscopes.** Barsotti, E.L. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE95003386. Source: OSTI; NTIS; INIS; GPO Dep.

A new longitudinal bunch monitoring system has been installed at Fermilab for the Tevatron and Main Ring. For each machine, a signal from a broadband wall current monitor is sampled and digitized by a high-speed oscilloscope. A Macintosh computer, running LabVIEW-based software, controls the scopes and CAMAC timing modules and analyzes the acquired data. The resulting bunch parameters are used for a variety of purposes, including Tevatron collider luminosity calculation and injection analysis. This paper examines the system in detail.

6389 (FNAL-TM–1910) **Procedure to determine the two channel timing measurement accuracy and precision of a digital oscilloscope.** Johnson, M.; Matulik, M. Fermi National Accelerator Lab., Batavia, IL (United States). 17 Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE95004351. Source: OSTI; NTIS; INIS; GPO Dep.

The digital oscilloscope allows one to make numerous timing measurements, but just how good are those measurements? This document describes a procedure which can be used to determine the accuracy and precision to which a digital oscilloscope can make various two channel timing measurements.

6390 (JAERI-Data/Code–94-012) **Benchmark problems for intermediate and high energy accelerator shielding.** Nakashima, Hiroshi (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Sakamoto, Yukio; Tanaka, Shun-ichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1994. 98p. Order Number DE95737270. Source: OSTI; NTIS; INIS.

Six kinds of benchmark problems were selected for evaluating the model codes and the nuclear data for the intermediate and high energy accelerator shielding by the Shielding Subcommittee in the Research Committee on Reactor Physics. The benchmark problems contain three kinds of neutron production data from thick targets due to proton, alpha and electron, and three kinds of shielding data for secondary neutron and photon generated by proton. Neutron and photoneutron reaction cross section data are also provided for neutrons up to 500 MeV and photons up to 300 MeV, respectively. (author).

6391 (KEK-PROC–93-10, pp. 296-298) **Off-line tests of superconducting resonators of the JAERI tandem booster.** Shibata, Michihiro (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Ishii, Tetsuro; Takeuchi, Suehiro. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

The JAERI tandem booster linac, which consists of 46 superconducting quarter wave resonators, is under construction. Off-line tests for resonators were performed. Accelerating field levels of 7MV/m were obtained at an rf input of 4W with most resonators. A maximum field level of 12.7MV/m was obtained. The Q-value was degraded when resonators were cooled down slowly around a temperature of 120K. We investigated this phenomenon by changing the cooling rate. (author).

6392 (KEK-PROC–93-10, pp. 299-303) **Q-degradation due to hydrogen in high pure niobium cavities.** Saito, Kenji (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Kneisel, P. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

A high pure niobium material with a high thermal conductivity at the liquid helium temperature has been used for superconducting cavities to achieve a higher field gradient overcoming thermal instability. However, it has resulted in a problem four years ago. When the high pure niobium cavities are cooled down slowly around 100K, they suffer a large Q-degradation due to hydrogen picked up during chemical polishing. This phenomenon can be explained by a character of magnetic weak superconductor generated during the cooling down. In this paper we report the experimental phenomenon and discuss the theoretical explanation on this Q-degradation. (author).

6393 (KEK-PROC–93-10, pp. 304-308) **In-house L-band niobium single cell cavities at KEK.** Inoue, Hitoshi (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Kobayashi, Yoshiharu; Funahashi, Yoshisato; Koizumi, Susumu; Saito, Kenji; Noguchi, Shuichi; Kako, Eiji; Shishido, Toshio. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

For the TESLA (TeV Energy Superconducting Linear Accelerator) as an energy frontier accelerator of the next generation improving the performance of the niobium superconducting cavities is the most important issue and much reduction of fabrication cost of cavities is another key. Since manufacturing of niobium material requires hard techniques due to the easily oxidizable metal, fabrication of niobium cavities has been conducted in only companies providing enough equipments in Japan. KEK has accumulated the fabrication technics such as forming method by deep drawing, trimming, centering of beam tubes, electron beam welding and measurement of manufacturing error so on. We made in-house L-band single cell cavities using these technologies. In this paper we present these manufacturing of the niobium cavities and estimate the fabrication cost as exactly as possible. The manufacturing error is also described. (author).

6394 (KEK-PROC–93-10, pp. 309-312) **The research for surface treatment of cavities aiming at higher accelerating field.** Suzuki, Takafusa (Nomura Techno Research, Co. Ltd. Osaka (Japan)); Ikeda, Tokumi; Saito, Kenji; Higo, Toshiyasu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

Requirement of the surface treatment for complex structures as an accelerator has become stronger in recent years. The research and development for surfaces treatment of copper have been studied in order to realize smooth and clean surface of cavities. Three kinds of treatment methods were tested here. One is an electropolishing (EP), and the others are mixed acid and special acid (articles on sale) for chemical polishing. Wave guides shaped by WIRE-CUT were used for the test, and its surface roughness was about 10μm Rz. Three methods were compared in metal removal rate and surface roughness. Good performance was obtained in both EP and special acid. (author).

6395 (KEK-PROC–93-10, pp. 313-317) **Research and development of an ultra clean surface for RF cavities.** Miwa, Hajime (Nomura Techno Research, Co. Ltd., Osaka (Japan)); Ikeda, Tokumi; Suzuki, Takafusa; Kurosawa, Kiyosi; Kako, Eiji; Noguchi, Shuichi; Saito, Kenji; Kneisel, P. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

Suppression of field emission is essentially important in order to attain higher accelerating gradients. Therefore, elimination of residual dust particles on the inner surface of RF cavities is necessary. Surface of a niobium cavity was simulated in silicon wafers, and analysis of dust particles was performed by a particle counter used for semiconductor industries. Experimental results in various surface treatments and applications to niobium cavities are described in this paper. (author).

6396 (KEK-PROC–93-10, pp. 318-322) **Development of high purity niobium material for superconducting cavities.** Umezawa, Hiroaki (Tokyo Denkai Co., Ltd. (Japan)); Takeuchi, Koichi; Sakita, Kohei; Suzuki, Takafusa; Saito, Kenji; Noguchi, Shuichi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

For the superconducting niobium cavities, issues of thermal quench and field emission have to be solved to achieve a high field gradient (>25MV/m) for TESLA (TeV Energy Superconducting Linear Accelerator). In order to overcome the quench, upgrading of thermal conductivity of niobium material at the low temperature is very important. On the reduction of the field emission not only dust particles but also defect, impurity and inhomogeneity should be considered. Therefore development of high purity niobium material is very important to solve these issues. This paper describes the our latest R and D for high purity niobium material. (author).

6397 (KEK-PROC–93-10, pp. 323-326) **Manufacturing of the L band 9-cell niobium cavity.** Matsuoka, Masanori (Mitsubishi Heavy Industries Ltd., Kobe (Japan). Kobe Shipyard and Machinery Works); Ohkubo, Kohichi; Yamanaka, Toshiyuki; Kako, Eiji; Saito, Kenji; Shishido, Toshio; Ono, Masaaki; Noguchi, Shuichi. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

Since 1990, L-band niobium superconducting cavities have been developed with collaboration between our company and National Laboratory for High Energy Physics (KEK). The manufacturing procedure and the performance of 9-cell superconducting cavity are presented. The maximum accelerating gradient of 12 MV/m was attained in a cold test. (author).

6398 (KEK-PROC–93-10, pp. 327-331) **High field tests of 1.3 GHz niobium superconducting cavities.** Kako, Eiji (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Noguchi, Shuichi; Ono, Masaaki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

Four single-cell cavities prepared by various surface treatments have been tested repeatedly since 1991. A maximum accelerating gradient of 25.1 MV/m with a high Q_0 value of $\approx 10^{10}$ was successfully achieved after heat treatment at 1400degC. A temperature mapping system with a high thermal sensitivity under superfluid helium was developed to understand phenomena limiting a maximum accelerating gradient. The cavity performances and the phenomena at high fields are reported in this paper. (author).

6399 (KEK-PROC–93-10, pp. 332-334) **The concept of parallel input/output processing for an electron linac.** Emoto, Takashi (Power Reactor and Nuclear Fuel Development Corp., Oarai, Ibaraki (Japan). Oarai Engineering Center). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

The instrumentation of and the control system for the PNC 10 MeV CW electron linac are described. A new concept of parallel input/output processing for the linac has been introduced. It is based on a substantial number of input/output processors(IOP) using beam control and diagnostics. The flexibility and simplicity of hardware/software are significant advantages with this scheme. (author).

6400 (KEK-PROC–93-10, pp. 335-339) **PC-based device-layer control system in the PF linac.** Abe, Isamu (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Nakahara, Kazuo; Mutoh, Masakatsu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

It has been tried to replace the device-layer mini-computer connected to CAMAC, which has been used more than 10 years in the Photon Factory 2.5 GeV e^-/e^+ linac, with recent powerful networked PCs. The processing speed has been improved at a low cost. The OOA(Object Oriented Analysis) is introduced in this system to make standard objects in the accelerator domain. (author).

6401 (KEK-PROC–93-10, pp. 340-342) **Upgrade of GUI for linac control.** Oonuma, Tadahiro (Tohoku Univ., Sendai (Japan). Lab. of Nuclear Science); Shibasaki, Yoshinobu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

We are now upgrading GUI(Graphical User Interface) of the control system at Tohoku Linac. This system uses Personal Computer (DECpc466D2LP-66MHz) and Visual Basic which makes coding GUI easy and simple. The first results of this system are presented. (author).

6402 (KEK-PROC–93-10, pp. 351-355) **New control system for the KEK-linac.** Kamikubota, N. (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Furukawa, K.; Nakahara, K.; Abe, I.; Akimoto, H. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

New control system for the KEK-Linac has been developed. Unix-based workstations and VME-bus computers are introduced. They are inter-connected with an Ethernet, which is used as a high-speed data-exchange network. New system will start the operation after October 1993. (author).

6403 (KEK-PROC–93-10, pp. 356-359) **Control system architecture of KEK 2.5 GeV linac.** Furukawa, Kazuro (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Kamikubota, Norihiko; Abe, Isamu; Nakahara, Kazuo. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

The control system of KEK 2.5 GeV linac is being rejuvenated. The main part of the hardware will be replaced and the architecture of its software is upgraded as well. System software has been developed to achieve new control scheme as well as old one. Since we invested in operator's console system which uses old control messages, we will continue support it. The new control scheme is based on the object oriented design of accelerator controls. It will enable the flexible and robust linac controls. (author).

6404 (KEK-PROC–93-10, pp. 360-362) **Operator interface using Tk widget. 2.** Furukawa, Kazuro (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Kamikubota, Norihiko; Kusano, Shirou. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

As accelerators got larger complex, it has become difficult to operate and understand whole accelerator. It is important to make effort to reduce information and to build easily configurable user-interface for operators. We have tested a building tool for graphical-user-interface called Tk in our Kek Linac control system. Tk is very efficient to develop user-interface for accelerator operation. The possible usage of Tk in our control system is described as well as its feature and performance. (author).

6405 (LA-UR–94-3350) **Noninterceptive beam energy measurements in line D of the Los Alamos Meson Physics Facility.** Gilpatrick, J.D.; Carter, H.; Plum, M.; Power, J.F.; Rose, C.R.; Shurter, R.B. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9410219–22: Beam instrumentation workshop, Vancouver (Canada), 2-6 Oct 1994). Order Number DE95003711. Source: OSTI; NTIS; INIS; GPO Dep.

Several members of the Accelerator and Operations Technology (AOT) division beam-diagnostics team performed time-of-flight (TOF) beam-energy measurements in line D of the Los Alamos Meson Physics Facility (LAMPF) using developmental beam time. These measurements provided information for a final design of an on-line beam energy measurement. The following paper discusses these measurements and how they apply to the final beam energy measurement design.

6406 (LA-UR–94-4040) **The Manuel Lujan Jr. Neutron Scattering Center.** Goldstone, J.A. (Los Alamos National Lab., NM (United States). Manuel Lujan Jr. Neutron Scattering Center). Los Alamos National Lab., NM (United States). [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–8: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003678. Source: OSTI; NTIS; INIS; GPO Dep.

High in the northcentral mountains of Los Alamos, New Mexico, is the Manuel Lujan Jr. Neutron Scattering Center (LANSCE), a pulsed-spallation neutron source located at Los Alamos National Laboratory. At LANSCE, neutrons are produced by spallation when a pulsed 800-MeV proton beam impinges on a tungsten target. The proton pulses are provided by a linear accelerator and an associated Proton Storage Ring (PSR), which alters the intensity, time structure, and repetition rate of the pulses. In October 1986, LANSCE was designated a national user facility, with a formal user program initiated in 1988. In July 1989, the LANSCE facility was dedicated as the Manuel Lujan Jr. Neutron Scattering Center in honor of the long-term Congressman from New Mexico. At present, the PSR operates with a proton pulse width of 0.27 μs at 20 Hz and 80 μA, attaining the highest peak neutron flux in the world and close to its goal of 100 μA, which would yield a peak thermal neutron flux of 10^{16} n/cm^{-2}s^{-1}. This paper discusses the target/moderator/reflector shield system, the LANSCE instruments, the facility improvement projects, and user programs.

6407 (LA-UR–94-4061) **Experimental and theoretical development towards a 500 MW, one-microsecond, L-band relativistic klystron amplifier.** Haynes, W.B.; Fazio, M.V.; Carlsten, B.E.; Stringfield, R.M. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9410218–4: Pulsed radio frequency sources for linear colliders, Long Island, NY (United States), 2-7 Oct 1994). Order Number DE95003682. Source: OSTI; NTIS (US Sales Only); GPO Dep.

This paper describes the experimental development of a long pulse, high current, annular beam relativistic klystron amplifier. The desired performance parameters are 1 GW output power and 1 μs pulse length with an operating frequency of 1.3 GHz. The electron beam voltage and current are nominally 600 kV and 5 kA. Peak powers approaching 500 MW have been achieved in pulses of 1 μs nominal baseline-to-baseline duration. The half power pulse width is 0.5 μs. These pulses contain an energy of about 160 J. The design of this class of tube presents some unique challenges, particularly in the output cavity. The output cavity must exhibit a very low gap shunt impedance in order to obtain reasonable conversion efficiency from the low impedance modulated electron beam to microwave power, while still maintaining a reasonable loaded Q for mode purity. The physics of this device is dominated by space charge effects which strongly impact the design. Current experimental results and theoretical design considerations for this class of tube, and scaling to higher frequency operation, suitable for the Next Linear Collider are discussed.

6408 (LA-UR–94-4118) **Optical and x-ray imaging of electron beams using synchrotron emission.** Wilke, M.D. Los Alamos National Lab., NM (United States). [1994]. 21p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9410219–20: Beam instrumentation workshop, Vancouver (Canada), 2-6 Oct 1994). Order Number DE95003637. Source: OSTI; NTIS; INIS; GPO Dep.

In the case of very low emittance electron and positron storage ring beams, it is impossible to make intrusive measurements of beam properties without increasing the emittance and possibly disrupting the beam. In cases where electron or positron beams have high average power densities (such as free electron laser linacs), intrusive probes such as wires and optical transition radiation screens or Cherenkov emitting screens can be easily damaged or destroyed. The optical and x-ray emissions from the bends in the storage rings and often from linac bending magnets can be used to image the beam profile to obtain emittance information about the beam. The techniques, advantages and limitations of using both optical and x-ray synchrotron emission to measure beam properties are discussed and the possibility of single bunch imaging is considered. The properties of suitable imagers and converters such as phosphors are described. Examples of previous, existing and planned applications are given where available, including a pinhole imaging system currently being designed for the Advanced Photon Source at Argonne National Laboratory.

6409 (LBL–35476-Exc.) **Superconducting magnets.** Lawrence Berkeley Lab., CA (United States). Aug 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95003813. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the following topics on superconducting magnets: D19B and -C: The next steps for a record-setting magnet; D20: The push beyond 10 T: Beyond D20: Speculations on the 16-T regime; other advanced magnets for accelerators; spinoff applications; APC materials development; cable and cabling-machine development; and high-$T_c$superconductor at low temperature.

6410 (LBL–35822) **Proceedings of the conference on computing in high energy physics '94.** Loken, S.C. (ed.). Lawrence Berkeley Lab., CA (United States). [1994]. 532p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-940492–: Meeting on computing in high-energy physics, San Francisco, CA (United States), 21-27 Apr 1994). Order Number DE95004442. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains papers on the following topics: Triggering, data acquisition, online and control systems; hardware architectures; networks and interconnections; data handling and storage systems; software methodologies, languages and tools; user interfaces and visualization; computation; and information systems and multimedia. The individual papers have been indexed and cataloged elsewhere.

6411 (LBL–36232) **Relativistic-klystron two-beam-accelerator as a power source for a 1 TeV next linear collider: A systems study.** Yu, S. (Lawrence Berkeley Lab., CA (United States)); Goffeney, N.; Deadrick, F. Lawrence Berkeley Lab., CA (United States). Oct 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9408125–43: 17. international LINAC conference, Tsukuba (Japan), 21-26 Aug 1994). Order Number DE95003425. Source: OSTI; NTIS; INIS; GPO Dep.

A physics, engineering, and costing study has been conducted to explore the feasibility of a relativistic-klystron two-beam-accelerator system as a power source candidate for a 1 TeV linear collider. We present a point design example which has acceptable transverse and longitudinal beam stability properties. Preliminary "bottom-up" cost estimate yields the full power source system at less than 1 billion dollars. The overall efficiency for rf production is estimated to be 36%.

6412 (LBL–36347) **Proceedings of the workshop on ion source issues relevant to a pulsed spallation neutron source: Part 2 workshop presentations.** Schroeder, L.; Leung, Ka-Ngo; Alonso, J. (eds.). Lawrence Berkeley Lab., CA (United States). Oct 1994. 531p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9410233–Pt.2:

Workshop on ion source issues relevant to a pulsed spallation neutron source, Berkeley, CA (United States), 24-26 Oct 1994). Order Number DE95004818. Source: OSTI; NTIS; INIS; GPO Dep.

As part of the Lawrence Berkeley Laboratory Pulsed Spallation Source study, this Workshop was convened to address ion-source technology's present status with respect to the next-generation Pulsed Spallation Source in the 1-5 MW range for the neutron scattering community. Considerations of Low Energy Beam Transport (LEBT) parameters and designs were included in the discussions throughout the Workshop. Ion-source requirements and actually-achieved performances were assessed, resulting in a determination of research and development requirements to bridge the gap. Part 1 of these Proceedings summarizes the Workshop; Part 2 contains viewgraphs of Workshop presentations.

6413 (SLAC-PUB–6624) **Higher order mode damping for a detuned structure.** Kroll, N. (California Univ., San Diego, La Jolla, CA (United States). Dept. of Physics); Thompson, K.; Bane, K.; Ko, K.; Miller, R.; Ruth, R.; Gluckstern, R. Stanford Linear Accelerator Center, Menlo Park, CA (United States); California Univ., San Diego, La Jolla, CA (United States). Dept. of Physics. Aug 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515 ; FG03-93ER40759. (CONF-9408125–44: 17. international LINAC conference, Tsukuba (Japan), 21-26 Aug 1994). Order Number DE95004283. Source: OSTI; NTIS; INIS; GPO Dep.

We report in this paper the current status of our investigation of the possibility of suppressing the wake reappearance by providing relatively weak damping via the vacuum manifolds. The four vacuum manifolds running the length of the structure also function as multimode waveguides which serve to drain power from the HOM's through the large coupling slots located in each cell, except, as discussed later, for a few at each end of the manifolds.

6414 (SLAC-PUB–6656) **Performance of the SLD Central Drift Chamber.** Hildreth, M.D. (and others); Junk, T.R.; Markiewicz, T.W. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-941061–8: Nuclear science symposium: medical imaging conference, Norfolk, VA (United States), 30 Oct - 5 nov 1994). Order Number DE95004285. Source: OSTI; NTIS; INIS; GPO Dep.

We report for the first time on the performance of the SLD Central Drift Chamber (CDC) at SLC, which has been recording data since 1992. The low mass of the chamber and the use of a gas characterized by both a low drift velocity and low diffusion constant help to minimize the drift-distance measurement errors. We describe some of the calibrations and corrections applied to the data, and report on the resolutions achieved thus far. We measure an intrinsic drift resolution of 55-110 μm in the region of uniform field. Analysis of the full drift-pulse waveform allows for efficient double-hit resolution of about 1 mm. Momentum resolution is characterized by the formula $(dp_t/p_t^2)^2 = 0.0050^2 + (0.010/p_t)^2$. Used in conjunction with the SLD vertex detector, the CDC permits measurements of impact parameters of high-momentum tracks to the level of 10 μm in the r-ϕ plane and 36 μm the r-z plane. A resolution of 6.4% is achieved in the measurement of dE/dx for the electrons in Bhabha scattering events.

6415 (SLAC-PUB–6660) **Manifold damping of the NLC detuned accelerating structure.** Kroll, N. (California Univ., San Diego, La Jolla, CA (United States)); Thompson, K.; Bane, K.; Ko, K.; Miller, R.; Ruth, R.; Gluckstern, R. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515 ; FG03-93ER40759. (CONF-940681–4: Advanced accelerator concepts workshop, Lake Geneva, WI (United States), 13-18 Jun 1994). Order Number DE95004286. Source: OSTI; NTIS; INIS; GPO Dep.

In order to investigate the reappearance of the HOM wakefield of a detuned accelerator structure and relax tolerance requirements, we propose to provide low level damping by coupling all cavities to several identical and symmetrically located waveguides (manifolds) which run parallel to each accelerator structure and are terminated at each end by matched loads. The waveguides are designed such that all modes which couple to the acceleration mode are non-propagating at the acceleration mode frequency. Hence the coupling irises can be designed to provide large coupling to higher frequency modes without damping the acceleration mode. Because the higher order modes are detuned, they are localized and have a broad spectrum of phase velocities of both signs. They are therefore capable of coupling effectively to all propagating modes in the waveguides. Methods of analyzing and results obtained for the very complex system of modes in the accelerating structure and manifolds are presented.

6416 (SLAC-PUB–6675) **Operation and performance of a longitudinal feedback system using digital signal processing.** Teytelman, D. (and others); Fox, J.; Hindi, H. Stanford Linear Accelerator Center, Menlo Park, CA (United States). 22 Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (LBL–36174; CONF-9410219–19: Beam instrumentation workshop, Vancouver (Canada), 2-6 Oct 1994). Order Number DE95004288. Source: OSTI; NTIS; INIS; GPO Dep.

A programmable longitudinal feedback system using a parallel array of AT&T 1610 digital signal processors has been developed as a component of the PEP-II R&D program. This system has been installed at the Advanced Light Source (LBL) and implements full speed bunch by bunch signal processing for storage rings with bunch spacing of 4ns. Open and closed loop results showing the action of the feedback system are presented, and the system is shown to damp coupled-bunch instabilities in the ALS. A unified PC-based software environment for the feedback system operation is also described.

6417 (SLAC-PUB–6689) **A ppM-focused klystron at X-band with a travelling-wave output structure.** Eppley, K.R. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9410218–3: Pulsed radio frequency sources for linear colliders, Long Island, NY (United States), 2-7 Oct 1994). Order Number DE95004289. Source: OSTI; NTIS; INIS; GPO Dep.

We have developed algorithms for designing disk-loaded travelling-wave output structures for X-band klystrons to be used in the SLAC NLC. We use either a four- or five-cell structure in a $\pi/2$ mode. The disk radii are tapered to produce an approximately constant gradient. The matching calculation is not performed on the tapered structure, but rather on a coupler whose input and output cells are the same as the final cell of the tapered structure, and whose interior cells are the same as the penultimate cell in the tapered structure. 2-D calculations using CONDOR model the waveguide as a radial transmission line of adjustable impedance. 3-D calculations with MAFIA model the actual rectangular waveguide and coupling slot. A good match is obtained by adjusting the impedance of the final cell. In 3D, this requires varying both the radius of the cell and the width of the aperture. When the output cell with the best match is inserted in the tapered structure, we obtain excellent cold-test agreement between the 2-D and 3-D models. We use hot-test simulations with CONDOR to design a structure with maximum efficiency and minimum surface fields. We have designed circuits at 11.424 GHz for different perveances. At 440 kV, microperveance 1.2, we calculated 81 MW, 53 percent efficiency, with peak surface field 76 MV/m. A microperveance 0.6 design was done using a ppM stack for focusing. At 470 kV, 193 amps, we calculated 58.7 MW, 64.7 percent efficiency, peak surface field 62.3 MV/m. At 500 kV, 212 amps, we calculated 67.1 MW, 63.3 percent efficiency, peak surface field 66.0 MV/m.

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Refer also to citation(s) 6416, 6808

6418 (ANL/APS/TB–19) **A finite element analysis of room temperature silicon crystals for the Advanced Photon Source bending-magnet and insertion-device beams.** Assoufid, L.; Lee, W.K.; Mills, D.M. Argonne National Lab., IL (United States). Advanced Photon Source Accelerator Systems Div. Aug 1994. 57p. Sponsored by USDOE, Washington, DC (United States). DOE

Contract W-31109-ENG-38. Order Number DE95004343. Source: OSTI; NTIS; INIS; GPO Dep.

The third generation of synchrotron radiation sources, such as the Advanced Photon Source (APS), will provide users with a high brilliance x-ray beam with high power and power densities. In many cases, the first optical component to intercept the x-ray beam is a silicon-crystal monochromator. Due to extreme heat loading, the photon throughput and brilliance will be severely degraded if the monochromator is not properly designed (or cooled). This document describes a series of finite element analyses performed on room temperature silicon for the three standard APS sources, namely, the bending magnet, Wiggler A, and Undulator A. The modeling is performed with the silicon cooled directly with water or liquid gallium through rectangular channels. The temperature distributions and thermally induced deformations are presented.

6419 (ANL/XFD/CP–82942) **Design of high heat load white-beam slits for wiggler/undulator beamlines at the Advanced Photon Source.** Shu, D.; Tcheskidov, V.; Nian, T.; Haeffner, D.R.; Alp, E.E.; Ryding, D.; Collins, J.; Li, Y.; Kuzay, T.M. Argonne National Lab., IL (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940714–41: International meeting on synchrotron radiation instrumentation, Stony Brook, NY (United States), 18-22 Jul 1994). Order Number DE95004136. Source: OSTI; NTIS; INIS; GPO Dep.

A set of horizontal and vertical white-beam slits has been designed for the Advanced Photon Source wiggler/undulator beamlines at Argonne National Laboratory. While this slit set can handle the high heat flux from on e APS undulator source, it has large enough aperture to be compatible with a wiggler source also. A grazing-incidence, knife-edge configuration has been used in the design to eliminate downstream X-ray scattering. Enhanced heat transfer technology has been used in the water-cooling system. A unique stepping parallelogram driving structure provides precise vertical slit motion with large optical aperture. The full design detail is presented in this paper.

6420 (ANL/XFD/CP–82943) **Beamline standard component designs for the Advanced Photon Source.** Shu, D.; Barraza, J.; Brite, C.; Chang, J.; Sanchez, T.; Tcheskidov, V.; Kuzay, T.M. Argonne National Lab., IL (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940714–42: International meeting on synchrotron radiation instrumentation, Stony Brook, NY (United States), 18-22 Jul 1994). Order Number DE95004135. Source: OSTI; NTIS; INIS; GPO Dep.

The Advanced Photon Source (APS) has initiated a design standardization and modularization activity for the APS synchrotron radiation beamline components. These standard components are included in components library, sub-components library and experimental station library. This paper briefly describes these standard components using both technical specifications and side view drawings.

6421 (ANL/XFD/CP–82944) **A double-multilayer monochromator using a modular design for the Advanced Photon Source.** Shu, D.; Yun, W.; Lai, B.; Barraza, J.; Kuzay, T.M. Argonne National Lab., IL (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940714–43: International meeting on synchrotron radiation instrumentation, Stony Brook, NY (United States), 18-22 Jul 1994). Order Number DE95004134. Source: OSTI; NTIS; INIS; GPO Dep.

A novel double-multilayer monochromator has been designed for the Advanced Photon Source X-ray undulator beamline at Argonne National Laboratory. The monochromator consists of two ultra high-vacuum (UHV) compatible modular vessels, each with a sine-bar driving structure and a water-cooled multilayer holder. A high precision Y-Z stage is used to provide compensating motion for the second multilayer from outside the vacuum chamber so that the monochromator can fix the output monochromatic beam direction and angle during the energy scan in a narrow range. The design details for this monochromator are presented in this paper.

6422 (ANL/XFD/CP–82945) **Precision white-beam slit design for high power density x-ray undulator beamlines at the Advanced Photon Source.** Shu, D. (and others); Brite, C.; Nian, T. Argonne National Lab., IL (United States). [1994]. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940714–44: International meeting on synchrotron radiation instrumentation, Stony Brook, NY (United States), 18-22 Jul 1994). Order Number DE95004133. Source: OSTI; NTIS; INIS; GPO Dep.

A set of precision horizontal and vertical white-beam slits has been designed for the Advanced Photon Source (APS) X-ray undulator beamlines at Argonne National Laboratory. There are several new design concepts applied in this slit set, including: grazing-incidence knife-edge configuration to minimize the scattering of X-rays downstream, enhanced heat transfer tubing to provide water cooling, and a second slit to eliminate the thermal distortion on the slit knife edge. The novel aspect of this design is the use of two L-shaped knife-edge assemblies, which are manipulated by two precision X-Z stepping linear actuators. The principal and structural details of the design for this slit set are presented in this paper.

6423 (ANL/XFD/CP–82946) **Explosive bonding and its application in the Advanced Photon Source front-end and beamline components design.** Shu, D. (Argonne National Lab., IL (United States). Experimental Facilities Div.); Li, Y.; Ryding, D.; Kuzay, T.M.; Brasher, D. Argonne National Lab., IL (United States). [1994]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940714–45: International meeting on synchrotron radiation instrumentation, Stony Brook, NY (United States), 18-22 Jul 1994). Order Number DE95004132. Source: OSTI; NTIS; INIS; GPO Dep.

Explosive bonding is a bonding method in which the controlled energy of a detonating explosive is used to create a metallurgical bonding between two or more similar or dissimilar materials. Since 1991, a number of explosive-bonding joints have been designed for high-thermal-load ultrahigh-vacuum (UHV) compatible components in the Advanced Photon Source. A series of standardized explosive bonded joint units has also been designed and tested, such as: oxygen-free copper (OFHC) to stainless-steel vacuum joints for slits and shutters, GlidCop to stainless-steel vacuum joints for fixed masks, and GlidCop to OFHC thermal and mechanical joints for shutter face-plates, etc. The design and test results for the explosive bonding units to be used in the Advanced Photon Source front ends and beamlines will be discussed in this paper.

6424 (BNL–60991) **The large superconducting solenoids for the g-2 muon storage ring.** Bunce, G. (and others); Cullen, J.; Danby, G. Brookhaven National Lab., Upton, NY (United States). [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-941013–17: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95003958. Source: OSTI; NTIS; INIS; GPO Dep.

The g-2 muon storage ring at Brookhaven National Laboratory consists of four large superconducting solenoids. The two outer solenoids, which are 15.1 meters in diameter, share a common cryostat. The two inner solenoids, which are 13.4 meters in diameter, are in separate cryostats. The two 24 turn inner solenoids are operated at an opposite polarity from the two 24 turn outer solenoids. This generates a dipole field between the inner and outer solenoids. The flux between the solenoids is returned through a C shaped iron return yoke that also shapes the dipole field. The integrated field around the 14 meter diameter storage ring must be good to about 1 part in one million over the 90 mm dia. circular cross section where the muons are stored, averaged over the azimuth. When the four solenoids carry their 5300 A design current, the field in the 18 centimeter gap between the poles is 1.45 T. When the solenoid operates at its design current 5.5 MJ is stored between the poles. The solenoids were wound on site at Brookhaven National Laboratory. The cryostats were built around the solenoid windings which are indirectly cooled using two-phase helium.

6425 (JAERI-Research–94-021) **Experiment and simulation of an electron/positron convertor for SPring-8.** Mizuno, Akihiko (JAERI-RIKEN SPring-8 Project Team, Tokyo (Japan)); Suzuki,

Shinsuke; Yoshikawa, Hiroshi; Hori, Toshihiko; Yanagida, Kenichi; Yokomizo, Hideaki. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1994. 56p. (In Japanese). Order Number DE95737275. Source: OSTI; NTIS; INIS.

In the SPring-8, positron beam will be used for increasing beam-lifetime in the Storage-ring. An electron/positron convertor will be installed in the middle of the Linac. For designing the convertor, experiments of positron generation and focusing were carried out with a test apparatus which was mounted in the beam-line of the JAERI-Linac. And we had been also developing a simulation code for the convertor. Simulation was already reported in JAERI-M 93-030, so this paper shows experiment results, and comparison between experiment and simulation. The experiment data are qualitatively coincident with that of simulation data. So this simulation code turned out to be available for designing the convertor. (author).

6426 (JAERI-Research–94-029) **Calculation of thermal deformations in water-cooled monochromator crystals.** Nakamura, Ario (JAERI-RIKEN SPring-8 Project Team, Tokyo (Japan)); Hashimoto, Shinya; Motohashi, Haruhiko. Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1994. 59p. (In Japanese). Order Number DE95737269. Source: OSTI; NTIS; INIS.

Through calculation of temperature distribution and thermal deformation of monochromators, optical degradation by the heat loads in SPring-8 have been discussed. Cooling experiments were made on three models of copper structures with the JAERI Electron Beam Irradiation Stand (JEBIS) and the results were used to estimate heat transfer coefficients in the models. The heat transfer coefficients have been adopted to simulate heating processes on silicon models of the same structures as the copper models, for which radiations from the SPring-8 bending magnet and the JAERI prototype undulator (WPH-33J) were considered. It has been concluded that, in the case of bending magnet (with power density of 0.27[MW/m^2] on monochromator surface), the temperature at the surface center reaches about 30[degC] from the initial temperature of 27[degC] in all the models. In the case of WPH-33J (with power density of 8.2[MW/m^2]), the temperature reaches about 200 to 280[degC] depending on the models. The radiation from WPH-33J yields slope errors bigger than the Darwin's width(23[μrad]). (author).

6427 (KEK-PROC–93-10, pp. 285-287) **Experiment on a 2-m accelerator section with a resonant ring.** Ohgoe, Takao (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)); Enomoto, Atsushi; Sato, Isamu. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

Acceleration using a resonant ring was tested for the TRISTAN-II (B-Factory) project. Feeding an input rf-power of about 30MW into an existing 2-m accelerator section, an energy of 54.1MeV was obtained. The average acceleration field reached 28.6MV/m, and the voltage multiplication factor with the resonant ring was about 1.4. (author).

6428 (KEK-PROC–93-10, pp. 346-350) **OS9 device driver in C.** Tamezane, Kenji (JAERI-RIKEN SPring-8 Project Team, Tokyo (Japan)); Sakaki, Hironao; Kodera, Masahiko; Yoshikawa, Hiroshi; Suzuki, Shinsuke; Yanagida, Kenichi; Mizuno, Akihiko; Hori, Toshihiko; Yokomizo, Hideaki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Aug 1993. (In Japanese). (CONF-9307187–: 18. linear accelerator meeting, Tsukuba (Japan), 21-23 Jul 1993). In *Proceedings of the 18th linear accelerator meeting in Japan.* 471p. Order Number DE94777550. Source: OSTI; NTIS; INIS.

The injector accelerators of SPring-8, 1 GeV linac and 8 GeV synchrotron, have distributed control systems using network and many VME computers. These are having many points must be modified after the facility is completed, and the system should be adapted to many requirements of users in a short time and low cost. For this purpose, the concept of object oriented programming(OOP) is inevitable to build up the software. We rewrite device drivers in C to get flexibility, transparency and ease of maintenance. Flexibility and transparency of device access contribute to good achievement of OOP control system. In this paper, the know-how the making device drivers in C and how to combine the C module with the assembler module are described. (author).

6429 (LBL–36279) **The LBL Advanced Light Source (ALS) transverse coupled-bunch feedback system: Recent commissioning results.** Barry, W.; Byrd, J.; Corlett, J. Lawrence Berkeley Lab., CA (United States). Oct 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9410219–18: Beam instrumentation workshop, Vancouver (Canada), 2-6 Oct 1994). Order Number DE95003424. Source: OSTI; NTIS; INIS; GPO Dep.

The ALS transverse coupled-bunch feedback system is described along with some recent commissioning results. Results presented include transfer function measurements, demonstrations of multi-bunch damping, and demonstrations of simultaneous transverse and longitudinal systems operation.

6430 (SLAC-PUB–6714) **Status of the PEP-II asymmetric B-Factory.** Mattison, T.S. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Nov 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC03-76SF00515 ; AC03-81ER40050 ; AS03-76ER70285 ; W-7405-ENG-48. (CONF-940816–55: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004291. Source: OSTI; NTIS; INIS; GPO Dep.

The PEP-II project is an e^+e^- storage ring complex with unequal energy beams to study CP violation in the B meson system. High luminosity requires a large number of bunches and a low value of beta at the collision point. The high beam current requires advances in vacuum chambers, damped RF cavities, and feedback systems. Machine elements inside the detector are required to achieve low beta values and magnetic separation.

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6431 (SAND–94-2404) **Primary standards laboratory report, 1st half 1994.** Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95003987. Source: OSTI; NTIS; GPO Dep.

Sandia National Laboratories operates the Primary Standards Laboratory for the Department of Energy, Albuquerque Operations Office (DOE/AL). This report summarizes metrology activities that received emphasis in the first half of 1994 and provides information pertinent to the operation of the DOE/AL system-wide Standards and Calibration Program.

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Refer also to citation(s) 5148, 5363, 5469, 5503, 5504, 6385, 6387, 6410, 6414, 6459, 6617, 6664, 6678, 6728, 6772, 6773

6432 (ANL/PHY/CP–84855) **Low-energy nuclear physics with high-segmentation silicon arrays.** Betts, R.R. (Argonne National Lab., IL (United States). Physics Div.). Argonne National Lab., IL (United States). Physics Div. [1994]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9409239–2: 29. Zakopane school of physics, Zakopane (Poland), 5-14 Sep 1994). Order Number DE95004118. Source: OSTI; NTIS; INIS; GPO Dep.

A brief history is given of silicon detectors leading up to the development of ion-implanted strip detectors. Two examples of their use in low energy nuclear physics are discussed; the search for exotic alpha-chain states in ^{24}Mg and studies of anomalous positron-electron pairs produced in collisions of very heavy ions.

6433 (BNL–61058) **Properties of melt-grown ZnSe solid-state radiation detectors.** Eissler, E.E. (II-VI Inc., Saxonburg, PA (United States)); Lynn, K.G. Brookhaven National Lab., Upton, NY (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-941061–10: Nuclear science symposium: medical imaging

conference, Norfolk, VA (United States), 30 Oct - 5 nov 1994). Order Number DE95003964. Source: OSTI; NTIS; INIS; GPO Dep.

Zinc Selenide (ZnSe) crystals grown using the High Pressure Bridgman (HPB) technique were used to fabricate solid-state radiation detectors measuring 10 x 10 x 2 mm^3. Sputtered platinum and gold contacts were applied to polished detector blanks. Voltage versus current characteristics were determined for the devices at 25 C. Pulse height spectra were obtained using ^{241}Am and ^{109}Cd at both 25 C and 150 C with applied bias of 9,000 V/cm. Current versus temperature was measured over the temperature range of 30 C to 150 C. Performance was measured at energies of 22.1 and 59.5 keV over a temperature range of −70 C to 170 C. Current versus dose rate was measured with 662 keV gamma irradiation. A value of the Mobility-Lifetime product ($\mu\tau$) for electrons was estimated. Time and temperature dependence of photo-peak position using Pulse Height Analysis (PHA) was studied.

6434 (CIEMAT–733) **Statistics of multi-tube detecting systems.** Grau Carles, P.; Grau Malonda, A. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 19p. (In Spanish). Order Number DE95721642. Source: OSTI; NTIS; INIS.

In this paper three new statistical theorems are demonstrated and applied. These theorems simplify very much the obtention of the formulae to compute the counting efficiency when the detection system is formed by several photomultipliers associated in coincidence and sume. These theorems are applied to several photomultiplier arrangements in order to show their potential and the application.

6435 (CIEMAT–742) **Probabilities and energies to obtain the counting efficiency of electron-capture nuclides, KLMN model.** Casas Galiano, G.; Grau Malonda, A. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 30p. (In Spanish). Order Number DE95722436. Source: OSTI; NTIS; INIS.

An intelligent computer program has been developed to obtain the mathematical formulae to compute the probabilities and reduced energies of the different atomic rearrangement pathways following electron-capture decay. Creation and annihilation operators for Auger and X processes have been introduced. Taking into account the symmetries associated with each process, 262 different pathways were obtained. This model allows us to obtain the influence of the M-electron-capture in the counting efficiency when the atomic number of the nuclide is high.

6436 (CIEMAT–743) **Liquid scintillation counting standardization of "125 I in organic and inorganic samples by the CIEMAT/NIST method.** Rodriguez Barquera, L.; Grau Malonda, A.; Los Arcos Merino, J.M.; Grau Carles, A. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 30p. (In Spanish). Order Number DE95722437. Source: OSTI; NTIS; INIS.

The liquid scintillation counting standardization of organic and inorganic samples of "125 I by the CIEMAT/NIST method using five different scintillators is described. The discrepancies between experimental and computed efficiencies are lower than 1.4% and 1.7%, for inorganic and organic samples, respectively, in the interval 421-226 of quenching parameter. Both organic and inorganic solutions have been standardized in terms of activity concentration to an overall uncertainty of 0.76%.

6437 (CIEMAT–753) **Preparation and LSC standardization of "89 Sr (DNP) using the CIEMAT/NIST method.** Rodriguez Barquero, L.; Arcos Merino, J.M. Los; Grau Malonda, A. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 22p. (In Spanish). Order Number DE95730388. Source: OSTI; NTIS; INIS.

A procedure for preparation of liquid scintillation counting samples of the strontium DNP complex, labelled with "89 Sr, is described. The chemical quench, the counting stability and spectral evolution of this compound is studied in six scintillators, Toluene, Toluene-alcohol, Dioxane-naphthalene, HiSafe II, Ultima-Gold and Instagel. The liquid scintillation standardization of "89Sr-DNP by the CIEMAT/NIST method, using Hisafe II and Ultima-Gold scintillators, has been carried out. The discrepancies between experimental and computed efficiencies are lower than 0.38% and 0.48%, respectively. The solution has been standardized in terms of activity concentration to an overall uncertainty of 0.38%. (Author)

6438 (CRN–94-09) **Detectors with gaseous micro strips (MSGC): realisation and tests.** Mack, V.; Barthe, S.; Bergdolt, A.M.; Blaes, R.; Brom, J.M.; Cailleret, J.; Christophel, E.; Coffin, J.; Eberle, H.; Fang, R.; Fontaine, J.C.; Geist, W.; Kachelhoffer, T.; Kettunen, H.; Michalon, A.; Pallares, A.; Romero, A.; Riester, J.L.; Schunck, J.P.;.Strasbourg-1 Univ., 67 (France). Centre de Recherches Nucleaires. 1994. 26p. (In French). Order Number DE95611193. Source: OSTI; NTIS (US Sales Only); INIS.

The idea of detectors with gaseous micro strips (MSGC) began in the year 1988. Their development seems to be very important for the future of experiments in high energy physics. The basic principle is the same that this one of threads chambers. In comparison with classical chambers the spatial resolution is broadly improved. 5 refs., 21 figs.

6439 (DESY–94-130) **Beam tests of prototype fiber detectors for the H1 forward proton spectrometer.** Baehr, J.; Hiller, K.; Hoffmann, B.; Luedecke, H.; Menchikov, A.; Nahnhauer, R.; Roloff, H.E.; Tonisch, F.; Voelkert, R. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Jul 1994. 24p. Order Number DE95725961. Source: OSTI; NTIS (US Sales Only); INIS.

Different prototypes of fiber detectors with an internal trigger system were tested in a 5 GeV electron beam at DESY. A silicon microstrip telescope was used for an external reference measurement of the beam to study the spatial resolution of the fiber detectors. On average 75% of all crossing electron tracks could be reconstructed with a precision better than 150 μm. These successful methodical investigations led to the installation of similar detectors in the proton beamline 81 m downstream of the central H1-detector at HERA as part of a forward proton spectrometer in spring 1994. (orig.)

6440 (FNAL/C–94/312) **Performance of a large scale scintillating fiber tracker using VLPC readout.** D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–64: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003746. Source: OSTI; NTIS; INIS; GPO Dep.

The authors report on results of a cosmic-ray test of a 3,072 channel scintillating fiber tracker using VLPC readout. This system is a prototype for the D0 detector tracking upgrade, and represents a configuration that is similar to that planned for the final detector. A detailed description of the cosmic ray test, including trigger, fiber configuration, lightguides, VLPC cassettes and cryogenics, calibration system, and DAQ is given. Tracking results with a muon momentum cutoff of 2.5 GeV/c include R-ϕ and R-Z resolution studies, light yield/mip, and efficiency measurements. Preliminary analysis gives a most probable value of 19.2 photoelectrons/mip per fiber doublet, an R-ϕ resolution of 163 microns (before corrections for fiber position survey), and an efficiency of nearly 100% after accounting for known dead channels in the system.

6441 (FNAL/C–94/318-E) **VLPC characterization for the Dzero upgrade.** D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–62: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003742. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have studied the performance characteristics of approximately 4,000 Visible Light Photon Counters (VLPC) over a range of operating temperatures and biases. They will describe the characterization procedure and present the measured gain, noise, and relative quantum efficiency for the devices. They will also discuss the general operation of the devices and the significant problems encountered during the characterization.

6442 (FNAL/C–94/335-E) **The D0 Silicon Tracker: A completely redesigned vertex detector.** Heinson, A.P. (California Univ., Riverside, CA (United States). Dept. of Physics). The D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–56: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003500. Source: OSTI; NTIS; INIS; GPO Dep.

Over the last year and a half, the D0 collaboration has undertaken a complete redesign of the Silicon Tracker for its upgrade. The new design optimizes geometrical acceptance and tracking efficiency for $|\eta| \leq 2$, in order to maximize the high transverse momentum physics accessible to D0 such as the top quark search. Details of the new design and reasons for the changes are presented here.

6443 (FNAL/C–94/352-E) **Operation and performance of the silicon vertex detector (SVX') at CDF.** Singh, P.P. (Univ. of Pittsburgh, PA (United States). Dept. of Physics and Astronomy). Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–60: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003380. Source: OSTI; NTIS; INIS; GPO Dep.

The authors describe the operation and performance of the Silicon Vertex Detector (SVX'), which replaced the CDF SVX detector for run Ib of the Fermilab Tevatron Collider. The new features of the SVX' include AC coupled readout, Field OXide Field Effect Transistor (FOXFET) biasing and radiation hard front end electronics. The authors expect the detector to survive beyond the 100 pb^{-1} of data taking anticipated for the present CDF physics run. Preliminary results from the collider data show that the detector has a resolution of about 12 μm. This provides a powerful tool to do top and bottom physics.

6444 (FNAL/C–94/370) **Dv upgrade muon electronics design.** Baldin, B.; Green, D.; Haggerty, H.; Hansen, S. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-941061–9: Nuclear science symposium: medical imaging conference, Norfolk, VA (United States), 30 Oct - 5 nov 1994). Order Number DE95003744. Source: OSTI; NTIS; INIS; GPO Dep.

The planned luminosity for the upgrade is ten times higher than at present ($L \sim 10^{32} cm^{-2} s^{-1}$) and involves a time between collisions as small as 132 ns. To operate in this environment, completely new electronics is required for the 17,500 proportional drift tubes of the system. These electronics include a deadtimeless readout, a digital TDC with about 1 ns binning for the wire signals, fast charge integrators and pipelined ADCs for digitizing the pad electrode signals, a new wire signal triggering scheme and its associated trigger logic, and high level DSP processing. Some test results of measurements performed on prototype channels and a comparison with the existing electronics are presented.

6445 (FNAL/C–94/372) **A high speed digitizing photomultiplier tube base for the KTeV CsI calorimeter.** Whitmore, J. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9409268–1: 5. international conference on calorimetry in high energy physics, Upton, NY (United States), 25 Sep - 1 oct 1994). Order Number DE95003739. Source: OSTI; NTIS; INIS; GPO Dep.

A circuit has been designed to digitize PMT signals over an 18-bit dynamic range with 8-bits of resolution. The crucial element of the circuit is the custom charge integrating and encoding (QIE) ASIC. This chip is designed to operate at rates up to 53 MHz, and, in conjunction with an 8-bit FADC, generates 12-bit floating point output. Bench tests of a 17-bit version of the digital base demonstrated excellent noise performance, linearity and pedestal and gain stability. Twenty-five channels of digitizing PMT bases have been built and used for readout of a CsI array in a test beam at CERN. Performance of these devices in a beam environment is discussed.

6446 (FNAL/C–94/375-E) **Double-sided silicon microstrip sensors for the CDF SVX II detector.** Seidel, S. (Fermi National Accelerator Lab., Batavia, IL (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–66: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004235. Source: OSTI; NTIS; INIS; GPO Dep.

The SVX II is the planned third-generation silicon vertex detector in the Collider Detector at Fermilab. Now in the prototyping phase, it is scheduled for operation in Tevatron Run II. This document describes aspects of the detector related to the design of the silicon microstrip sensors.

6447 (FNAL/C–94/377-E) **The CDF silicon vertex detector SVX and its upgrades.** Seidel, S. (Fermi National Accelerator Lab., Batavia, IL (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9306398–1: 2. workshop on vertex detectors, Lake Bohinji (Slovenia), 12-17 Jun 1993). Order Number DE95003743. Source: OSTI; NTIS; INIS; GPO Dep.

The three generations of CDF silicon vertex detectors, SVX, SVX′, and SVX II, are described. SVX, which operated during Tevatron run Ia, achieved 10.6 μm resolution in $r - \phi$. SVX′ is a radiation-hard device for run Ib with a similar but improved mechanical design and improved signal/noise. SVX II, which will be installed for run II, will track in three dimensions with radiation tolerance and electronics appropriate to a Main Injector environment.

6448 (FNAL/C–94/398) **The KTeV PMT laser monitoring system.** Nguyen, H.H. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9409268–2: 5. international conference on calorimetry in high energy physics, Upton, NY (United States), 25 Sep - 1 oct 1994). Order Number DE95004237. Source: OSTI; NTIS; INIS; GPO Dep.

The KTeV (Kaons at the TeVatron) collaboration is currently building a high-precision, pure CsI electromagnetic calorimeter with sophisticated digital readout. The KTeV CsI electromagnetic calorimeter will be monitored in situ by a light pulser system. Pulsed light from a liquid dye scintillator, itself pumped by a Nd:YAG laser, will be injected into each PMT of the calorimeter. The system is designed to linearize the response of the combined PMT and readout electronics, as well as monitor the gains of the PMT's.

6449 (FNAL-TM–1906) **Standardization of CDF and Dv reported luminosities.** Bantly, J.; Plunkett, R.; Pruss, S.; Tartaglia, M. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE95003388. Source: OSTI; NTIS; INIS; GPO Dep.

During FNAL collider store 5094, CDF- and Dv modified the computation of their reported luminosities to utilize a standardized world average inelastic cross-section. The changes made at each experiment and in the Accelerator Division are detailed below. A net decrease was expected and was observed for the reported instantaneous luminosity from each experiment. These changes affect the estimates of instantaneous and integrated luminosities reported to the Accelerator Division for the purposes of operational coordination.

6450 (FNAL-TM–1913) **Operation and tests of a DDC101 A/D.** Nguyen, H. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. Order Number DE95003747. Source: OSTI; NTIS; INIS; GPO Dep.

For the KTeV PMT laser monitoring system, one needs a high resolution device with a large dynamic range to be used for digitizing PIN photodiodes. The dynamic range should be wider than or comparable to the KTeV digitizer (17-bits). The Burr-Brown DDC101 is a precision, wide dynamic range, charge digitizing A/D converter with 20-bit resolution, packaged in a 28-pin plastic, double-wide DP. Low level current output devices, such as photosensors can be directly connected to its input. The digital output

can be clocked-out serially from the pins. For typical operations, a relatively wide gate of 1 msec should be used. The full scale charge is 500 pC for unipolar mode. The bipolar mode scale is ± 250 pC. The advertised integral nonlinearity is 0.003% of FSR. This document describes only the basic DDC101 operations since full detail can be found in the DDC101 manual. Tests results are given in section 3.

6451 (LA–12833-MS) **Calculations of the neutron response of boron-loaded scintillators.** Byrd, R.C.; Urban, W.T. Los Alamos National Lab., NM (United States). Dec 1994. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003489. Source: OSTI; NTIS (US Sales Only); GPO Dep.

Computer simulations of the neutron response of scintillation detectors have traditionally required specialized computer programs that account for the nonlinear conversion between deposited energy and light output. Such codes, however, do not allow the flexible choices of geometry and materials incorporated in general-purpose programs such as the Monte Carlo N-Particle (MCNP) transport code developed at Los Alamos National Laboratory. The newest version of this program (MCNP4A) provides a convenient option to select particular neutron events for output to a detailed history file. This new option is especially useful for modeling boron-loaded plastic (BC454) scintillators, whose response cannot be described using either the specialized scintillator programs or previous versions of the MCNP code. In particular, such detectors can be used as neutron spectrometers by selecting proton recoil signals from only events where the incident neutron has deposited essentially its entire energy in the detector. Using the new MCNP4A techniques, this report presents a detailed study of the capabilities of BC454 scintillators for neutron spectroscopy. New calculations are compared with those from previous studies of conventional and boron-loaded scintillators, and complete parameterizations are developed to describe the energy-to-light conversion, detection efficiency, and angular sensitivity of BC454-based detectors. These relations are then inverted to provide measurements of energy spectra for incident neutrons from arbitrary incident directions, leading to predictions of energy spectra that obtain resolutions of 25-40% without any unfolding. Using techniques for neutron-by-neutron energy measurements also allows comparisons with previous measurements made using prototype detectors. The success of these comparisons provides the basis for developing a portable version of the instrument, the Field Neutron Spectrometer.

6452 (LA-SUB–94-95) **Fluorescent materials consultation. Final report, 15 August 1987–30 September 1989.** Locker, D. Los Alamos National Lab., NM (United States); RDA Logicon, Albuquerque, NM (United States). [1989]. 3p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94015400. Source: OSTI; NTIS; GPO Dep.

Paper briefly describes the technical assistance that R&D Associates of Albuquerque, NM provided to Los Alamos National Laboratories/CLS in neutral particle beam direction sensing. Subcontractor assisted in making CLS e-beam machine functional, concluded that high-aspect detector element formats would be highly beneficial for a Wire and Fluorescent Fiber Offset Grid (WAFFOG) device, and designed a method used to coat ribbons and wires with fluor for a subscale WAFFOG. Work done during the course of this subcontract resulted in innovations which could extend the usefulness of the WAFFOG concept and furthered understanding of the WAFFOG boresighting problem. Later technical extensions include registered neutral particle beam scoring and methods for emulating or impressing acquisition, tracking, and pointing into a neutral particle beam facility function.

6453 (LBL–34831, pp. 341-352) **The PHENIX experiment at RHIC.** Tonse, S.R. (Lawrence Livermore National Lab., CA (United States)); Thomas, J.H. Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Later this decade the Relativistic Heavy Ion Collider (RHIC) will be built at Brookhaven Natl. Lab. Its goals will be to accelerate and collide Au beams at 100 GeV/c in an attempt to create a Quark Gluon Plasma (QGP). The PHENIX detector aims to detect the QGP through its leptonic and hadronic signatures. The authors describe here its physics capabilities and the details of the apparatus designed to pick out rare leptonic signatures from among hadronic multiplicities of up to 1500 particles per unit of rapidity.

6454 (LBL–34831, pp. 353-361) **The STAR experiment at RHIC.** Harris, J.W. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract AC03-76SF00098. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

An overview of the Solenoidal Tracker at RHIC (STAR) experiment and the anticipated physics program is presented. The STAR experiment will concentrate on hadronic observables over a large solid angle at the Relativistic Heavy Ion Collider in order to measure event-by-event characteristics of the collisions. STAR will search for signatures of the Quark-Gluon Plasma and investigate the behaviour of strongly-interacting matter at high energy density.

6455 (MPI-PhE–94-13) **Low-energy X-ray detection in cryogenic detectors with tungsten thermometers.** Colling, P.; Nucciotti, A.; Bucci, C.; Cooper, S.; Ferger, P.; Frank, M.; Nagel, U.; Proebst, F.; Seidel, W. Max-Planck-Institut fuer Physik, Muenchen (Germany). Werner-Heisenberg-Institut. Aug 1994. 20p. Order Number DE95725943. Source: OSTI; NTIS (US Sales Only); INIS.

In the course of our development of calorimetric particle detectors with superconducting phase transition thermometers, we have succeeded in depositing epitaxial α-tungsten films on sapphire which have critical temperatures T_c near 15 mK. To our knowledge this is the first time that the T_c of bulk tungsten has been observed in thin films. Such films used as thermometers are very sensitive and provide good energy resolution: with 4 g and 32 g sapphire crystals energy resolutions of better than 100eV (FWHM) for 1.5 KeV X-rays have been achieved. (orig.)

6456 (MPI-PhE–94-14) **Model for cryogenic particle detectors with superconducting phase transition thermometers.** Proebst, F.; Frank, M.; Cooper, S.; Colling, P.; Dummer, D.; Ferger, P.; Nucciotti, A.; Seidel, W.; Stodolsky, L. No corporate text available. Sep 1994. 32p. Order Number DE95731743. Source: OSTI; NTIS (US Sales Only); INIS.

We present data on a detector composed of an 18 g Si crystal and a superconducting phase transition thermometer which could be operated over a wide temperature range. An energy resolution of 1 keV (FWHM) has been obtained for 60 keV photons. The signals consist of two components: A fast one and a slow one, with decay times of 1.5 ms and 30-60 ms, respectively. In this paper we present a simple model which takes thermal and non-thermal phonon processes into account and provides a description of the observed temperature dependence of the pulse shape. The fast component, which completely dominates the signal at low temperatures, is due to high-frequency non-thermal phonons being absorbed in the thermometer. Thermalization of these phonons then leads to a temperature rise of the absorber, which causes the slow thermal component. At the highest operating temperatures ($T \approx 80$ mK) the amplitude of the slow component is roughly as expected from the heat capacity of the absorber. The strong suppression of the slow component at low temperatures is explained mostly as a consequence of the weak thermal coupling between electrons and phonons in the thermometer at low temperatures. (orig.)

6457 (UCRL-JC–116456) **Characteristics of an ultrafast x-ray streak camera.** Shepherd, R. (and others); Booth, R.; Price, D. Lawrence Livermore National Lab., CA (United States). Jun 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940723–32: Annual meeting of the Society of Photo-Optical Instrumentation Engineers, San Diego, CA (United States), 24-29 Jul 1994). Order Number DE95004210. Source: OSTI; NTIS; GPO Dep.

The detection and temporal dispersion of the x-rays using x-ray streak cameras has been limited to a resolution of 2 ps, primarily

due to the transit time dispersion of the electrons between the photocathode and the acceleration grid. The transit time spread of the electrons traveling from the photocathode to the acceleration grid is inversely proportional to the accelerating field. By increasing the field by a factor of 7, we have minimized the effects of transit time dispersion in the photocathode/accelerating grid region and produce an x-ray streak camera with sub-picosecond temporal resolution (~900 fs). The streak camera has been calibrated using a Michelson interferometer and 100 fs, 400 nm laser light. Time resolved x-ray data is shown from an aluminum target heated at 10^{18} W/cm^2 with a 100 fs, 400 nm laser.

4404 Well Logging Instrumentation

Refer also to citation(s) 5597, 5606, 5607, 5626, 5627, 6517, 6518

6458 (CONF-9405258–, pp. 17-19) **Survey of pile penetration with velocity logging.** Inoue, S. (Taisei Kisosekkei Co. Ltd., Tokyo (Japan)); Kurimoto, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Acoustic velocity was logged to survey the penetration state of existing bridge foundation pile which remained underground. The result of logging was reported. Boring was made behind the bridge abutment to grasp the ground structure and underwater level, and log the acoustic velocity in the vicinity of existing bridge. For the acoustic velocity logging, measurement was continuously made, by downhole method, with a horizontal component array geophone, amplifier and recorder. Vibration was generated by hammering at the top of abutment. The location of pile end was presumed from the refraction point of travel-time curve due to the difference in seismic wave velocity between the inside of pile and underground soil. As a result of measurement, difference in slope of travel-time curve was generated at the depth of about 9 to 10m. The slope was 2500 and 1200m/s in the shallower range and deeper range, respectively. The former velocity and latter velocity were judged to be mainly in the inside of existing concrete pile and underground stratum, respectively. The pile end depth was presumed to be 10m within an error of 0.5m. Data are dispersed in the shallower part, so that the pile penetration is estimated with difficulty. 1 ref., 4 figs.

6459 (CONF-9405258–, pp. 20-21) **Conversion from radioactive counts to density.** Matsuyama, M. (Daiwa Exploration and Consulting Company, Tokyo (Japan)). Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper explained how to convert the observed radiant quantity into the density for the density logging. According to the principle of Compton scattering, the scattering intensity of radiant rays to the irradiated object is a function of radiation source intensity, object density and environmental factor. The environmental factor is a parameter which characteristically reflects the pore diameter, mud water, casing and measuring instrument. It can be determined, by least square, from relational formulae through measurement at two or more points with a density presumed to be known. Practically, sample is collected from the borehole. The weight is obtained per unit volume. Then by combing it with the observed values, the radiation source intensity and environmental factor are determined. As a density conversion method for the density logging, there is a method in which the radiation source intensity and environmental factor are fixed in advance with artificial samples of which the density is already known. However, that method is not always simple because measurement must have been made under many combined conditions. Though it is necessary for the present method to measure the weight per unit volume, it is judged not to be a so heavy burden.

6460 (CONF-9405258–, pp. 22-26) **Comparison between VSP travel times and sonic integrated times. 2nd Report.** Tezuka, K. (Japan Petroleum Exploration Co. Ltd., Tokyo (Japan)); Miyairi, M.; Matsuoka, T.; Takahashi, A.; Arakawa, Y. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Study with borehole data was made to investigate the cause of discrepancy between the seismic exploration record and synthetic seismic record. As a cause of discrepancy between the VSP travel time and sonic integrated time, investigated were the dispersion of seismic wave, refraction of VSP wave in the dip stratum, physical change in the vicinity of borehole. As a result, why that discrepancy tends to be large in the mud, sand and other depositional strata was known to be explainable by the dispersion of seismic wave. The influence to be brought by the dip of stratum was judged to be not considerably large, because high-angle dip stratum was not given in the borehole data for the present study. Though the study was intended to investigate the influence of velocity lowered by the change in physical properties in the vicinity of borehole, possibility of measuring the velocity in the alteration zone was suggested because the exploration depth of acoustic wave logging was not sufficient in the igneous rock stratum. As compared with the conventional synthetic seismic record, the presently prepared one based on the dispersion theory for the borehole which showed a monotonous increase in travel time differential gave a result which agreed well to the actual section of VSP reflection, so that it was proved effective to take the dispersion into consideration. 5 refs., 8 figs.

6461 (CONF-9405258–, pp. 27-30) **Field experiment of 3D reverse VSP.** Takahashi, T. (OYO Corp., Tokyo (Japan)); Ando, N. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Exploration experiment was made to confirm whether the reverse VSP method in which the vibration is generated in the borehole and received on the ground surface is effective or not. Downward from the ground surface in the site, there extends homogeneous Tertiary Period's mudstone, in which thin tuff's parting layers and crush zone are distributed as a low-angle dip stratum with a thickness of 10cm to 1m. The experiment aimed at knowing the distribution of such thin strata and their dip in order to investigate the resolving power of strata and ability of three-dimensional exploration by the present method. The boreholes were 50m in length and positioned radially with observation points which were 5m in offset distance and 20m or less in interval on the ground surface. In the borehole, the vibration was generated by a small quantity of dynamite exploded every 1m from the depth of 50m up to the ground surface. As a result, the reflected high frequency P-wave which was 300Hz in frequency could be observed so that thin strata which were 1m or less in thickness were clearly detected. The strike and dip were obtained which agreed in value with those presumed through a geological survey by three-dimensional migration image. 1 ref., 8 figs.

4406 Optical Instrumentation

Refer also to citation(s) 5433, 6871

6462 (CONF-9405258–, pp. 41-45) **Cross-polarization borehole radar system with a RF analog optical transmission link.** Miwa, T. (Tohoku University, Sendai (Japan). Faculty of

Engineering); Sato, M.; Niitsuma, H. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The cross-polarization borehole radar system (BRS) was reported. The RF analogue optical transmission system (using the optical fiber cable) was introduced into the signal transmission between the sonde and the surface station to broaden the band and to heighten the S/N ratio. The sonde consisted of cable head (to transmit the trigger signal), receiving antenna, and transmitting antenna. The transmitting antenna was excited by the trigger signal from the surface to generate the pulse by the pulse generator. The signal received by the receiving antenna was sent to the oscilloscope on the surface. The field test of cross-polarization borehole system revealed that the effect of noise associated with the BRS employing the eccentric cable did not appear on the BRS. Examples of field test of the cross-polarization borehole measurement system employing the BRS were described. 4 refs., 8 figs., 1 tab.

6463 (CRIE-R–93009) **Application of optical fiber amplifier for wavelength division multiplexing communication system. Part 2. Design of four-channel transmission system using two EDFA repeaters.** Isawa, K.; Kurono, M.; Kuribara, M. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1994. 34p. (In Japanese). Order Number DE95730179. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

Circuit design was made in case of applying an Er^{3+}-doped fiber amplifier (EDFA) to the conventional one-wavelength optical communication system and four-wavelength division multiplexing optical communication system with two in-line amplifiers. Circuit-designed to use two EDFA's for amplifying an optical signal with a wavelength of 1540nm, the one-wavelength optical communication system experimentally demonstrated that the circuit could be formed to the maximum length of 180km. In the remote pumping through the signal transmission line used as a pumped optical supply line, the electric source is not necessary at the amplification point, so that the EDFA can be utilized under a good condition, if the pumped optical output is sufficiently high. The wavelength to pump the EDFA is 0.98μm and 1.48μm. Circuit-designed to multiplex wavelengths around 1555nm, the four-wavelength division multiplexing optical communication system with two in-line amplifiers gives the smallest difference in output among wavelengths on condition that the wavelength is set to equalize the amplified wavelength output at both transmission and reception points at the required input level. Mutual relation was elucidated among the in-line input level, working wavelength band and transmission distance. 8 refs., 41 figs.

4407 Geophysical and Meteorological Instrumentation

Refer also to citation(s) 5604, 5610, 5613, 5614, 5617, 5628, 6356, 6538

6464 (CONF-9405258–, pp. 175-178) **Development and application of an acoustic profiling system for detection of wedge-like saline layer.** Nishimura, K. (Geological Survey of Japan, Tsukuba (Japan)); Inouchi, Y.; Ishihara, T.; Tokuoka, T.; Anma, K.; Tsuchiya, Y.; Ishihara, T. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper reports a system developed to be used for detecting the wedge-like saline layer. The survey instrument of that system is functionally to transmit the acoustic wave (200kHz in frequency) from an electric strain type wave transmitter/receiver, and amplify, detect and record the received signal of that wave which is sent back at 200kHz kept intact without conversion in frequency. With that survey instrument, connected is a digital geologger which is developed to collect and record, with fidelity, the very weak reflected waveform, and composed of A/D converter and EXABYTE tape driver. An example of having recorded the following is exhibited as a result of survey conducted with the present system in Lake Nakanoumi, Shimane Prefecture: there exist several horizontal reflection surfaces proving the existence of layers of discontinuity about 4 to 5m below the level of lake surface. If the lake water is depthwise demarcated about 5m below it, the shallower water is fresh water containing a large quantity of dispersed matter which is judged to be floating matter, while the deeper water is acoustically limpid sea water almost without floating matter and has layered structure grasped. 3 refs., 6 figs., 1 tab.

6465 (CONF-9405258–, pp. 479-481) **On measuring settlement at each sea bed layer by magnetic measurement system.** Kusumi, H. (Kansai University, Osaka (Japan). Faculty of Engineering); Nishida, K.; Okuno, J.; Nishimura, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The present paper explains how to measure, by magnetic measurement system, the seabed settlement layer by layer. Sequentially, the measurement is to drill a borehole at the measurement spot, insert a hole-retaining pipe to prevent the hole wall from tumbling down, pile the hole wall with settlement elements (permanent magnets), perpendicularly lower a probe (equipped with two magnetic sensors) and measure the change in unbalanced current generated in the magnetic sensor by the probe's passing the settlement elements, which can be therefore located with accuracy by mm. By the present system, measurement was made for about seven years with about 120m deep observation holes drilled in the soil-improved and unimproved grounds of Rokko Island, Kobe City. As a result of that measurement, the following is reported: the compression of multi-layer ground could be quantitatively grasped layer by layer in detail. Most of the compaction/settlement phenomena are generated in the alluvial clay layers. The effect of soil improvement was confirmed in the ground. 1 ref., 9 figs.

6466 (WHC-SD-EN-AP–181) **Instructions for borehole sampling.** Reynolds, K.D.; Lindsey, K.A. Westinghouse Hanford Co., Richland, WA (United States). 11 Nov 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95003857. Source: OSTI; NTIS; INIS; GPO Dep.

Geologic systems generally are complex with physical properties and trends that can be difficult to predict. Subsurface geology exerts a fundamental control on groundwater flow and contaminant transport. The primary source for direct observation of subsurface geologic information is a borehole. However, direct observations from a borehole essentially are limited to the diameter and spacing of boreholes and the quality of the information derived from the drilling. Because it is impractical to drill a borehole every few feet to obtain data, it is necessary to maximize the data gathered during limited drilling operations. A technically defensible balance between the customer's data quality objectives and control of drilling costs through limited drilling can be achieved with proper conduct of operations. This report presents the minimum criteria for geologic and hydrologic characterization and sampling that must be met during drilling. It outlines the sampling goals that need to be addressed when drilling boreholes, and the types of drilling techniques that work best to achieve these goals under the geologic conditions found at Hanford. This report provides general guidelines for: (1) how sampling methods are controlled by data needs, (2) how minimum sampling requirements change as knowledge and needs change, and (3) when drilling and sampling parameters need to be closely controlled with respect to the specific data needs. Consequently, the report is divided into two sections that

center on: (1) a discussion of basic categories of subsurface characterization, sampling, and sampling techniques, and (2) guidelines for determining which drilling and sampling techniques meet required characterization and sampling objectives.

4408 Miscellaneous Instrumentation

Refer also to citation(s) 6218, 6321, 6357, 6385, 6476, 6508, 6516, 6522, 6527, 6528

6467 (CONF-9305395–Summ.) **Meeting report: Sixth International Symposium on Resonance Ionization Spectroscopy and its Applications.** Omenetto, N. (Commission of the European Communities, Ispra (Italy). Environment Inst.); Benetti, P. Tennessee Univ., Knoxville, TN (United States). [1992]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-91ER61250. From 6. international symposium on resonance ionization spectroscopy; Santa Fe, NM (United States); 24-29 May 1993. Order Number DE95003537. Source: OSTI; NTIS; GPO Dep.

In this paper, an attempt will be made to give an overview of the scientific contents of the meeting. Since it would be impossible to cover exhaustively all the topics presented, we have tried to emphasize some applications, with special emphasis to the analytical aspects of the presentation. The Sixth International Symposium on Resonance Ionization Spectroscopy and its Applications (RIS-92) was held in Santa Fe, New Mexico, USA, from May 24 to 29, 1992.

6468 (KCP–613-4805) **Calorimetric measurement of energy of ultrasonic cleaners.** Harding, W.B. Allied-Signal Aerospace Co., Kansas City, MO (United States). Kansas City Div. Nov 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00613. Order Number DE95003938. Source: OSTI; NTIS; GPO Dep.

The development of a calorimeter that measured the power within an ultrasonic cleaning tank is presented. The principle involved is explained. Several types of calorimeter that were tested are described. Measurement of the power in an ultrasonic cleaner permits: (1) comparing different ultrasonic cleaners; (2) monitoring the performance of a specific cleaner; (3) measuring the distribution of power in a cleaning tank, and (4) evaluating the effects of process variables on the power.

6469 (SAND–95-8200) **Dynamic response of a transducer mounted at one end of an acoustical cavity which is subjected to a specified pressure at the open end of the cavity.** Benedetti, G.A.; Benson, J.Z. Sandia National Labs., Livermore, CA (United States). Nov 1994. 111p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004192. Source: OSTI; NTIS; GPO Dep.

The purpose of this report is to develop a mathematical model for a pressure transducer mounted in a fluid filled cavity (a system) and examine the pressure "measurement" error of the cavity and transducer by computing the dynamic response (output pressure) of the system to a specified pressure time history (input pressure). The "measurement" error is determined by comparing the calculated output pressure to the specified input pressure. The dynamic response of a transducer mounted at one end of a one-dimensional acoustical cavity is determined. The cavity is filled with a compressible isentropic fluid, and the fluid at the open end of the cavity (i.e., the boundary at $x = 0$) is subjected to a specified uniform axial input pressure. At the other end of the cavity the transducer is represented as a mass, spring, and damper system. Consequently, the boundary condition at $x = \ell$ is also time dependent. The general solution to the boundary value problem, as well as the steady state solution for periodic excitation, is obtained by integrating a coupled set of ordinary differential equations.

6470 (UCRL-JC–116021) **Nanostethoscopy: A new mode of operation of the atomic force microscope.** Keaton, A.; Holzrichter, J.F.; Balhorn, R.; Siekaus, W.J. Lawrence Livermore National Lab., CA (United States). Feb 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9403184–1: NATO Advanced Study Institute conference, Schluchsee (Germany), 7-18 Mar 1994). Order Number DE95003646. Source: OSTI; NTIS; GPO Dep.

The authors introduce a new mode of operation of the atomic force microscope (AFM). This detection scheme, a "Nano-Stethoscope". Involves using the atomic force microscope in a novel acoustic mode not generally recognized. The Nano-Stethoscope uses the conventional scanning feature to locate a desired site, positions the AFM microscope tip over the site, holds the cantilever stationary (in x and v) and records the tip's z-motion as a function of time. The tip/cantilever system thus functions as a micro-motion detector to respond to characteristic "pulsations", nano-configurational chances, or any other event that influences the position of the tip as a function of time. The authors have demonstrated the feasibility of using the tip of an AFM in this manner in a biological system with a measurement of the vibrations of an emerging shrimp egg nauplius (~3 μm. -10 Hz) and on the Angstrom scale in a non-biological system i.e. the thermal expansion of metal interconnect lines on a microelectronic circuit.

6471 (UCRL-JC–118476) **NTS-spill test facility wind tunnel exhaust plume characterization.** Kerr, R.; Goldwire, H.; Smith, D.; Rawlings, J.; Schaffer, T.; Robson, J. Los Alamos National Lab., NM (United States). Jul 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9404162–14: 1994 chemical analysis by laser interrogation of proliferation effluents (CALIOPE ITR) interim technical review, Livermore, CA (United States), 26-28 Apr 1994). Order Number DE95003630. Source: OSTI; NTIS; GPO Dep.

The exhaust plume of the NTS-STF wind tunnel has been characterized to demonstrate its suitability as a target for CALIOPE experiments. Smoke from grenades has been released in multiple quantities and at different positions inside the tunnel. The smoke plumes have been recorded on video tape. The wind velocity profile has also been determined with a moveable array of miniature vane anemometers. These measurements will be used to determine the vapor concentration pathlength as part of the ground truth.

45 MILITARY TECHNOLOGY, WEAPONRY, AND NATIONAL DEFENSE

Refer also to citation(s) 5146, 5147, 5149, 6022, 6023, 6024, 6025, 6026, 6027, 6316, 6361, 6632

6472 (K/DSRD–116) **Phase I verification and validation of SIMNET-T.** Hartley, D.S. III; Quillinan, J.D.; Kruse, K.L. Oak Ridge National Lab., TN (United States). May 1990. 81p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OT21400. Order Number DE95004574. Source: OSTI; NTIS (US Sales Only); GPO Dep.

SIMNET is a prototype system of tank and armored vehicle simulators connected by an electronic network. The prototype is being constructed by Bolt, Beranek, and Newman, Inc. (BBN) and Perceptronics for the Defense Advanced Research Projects Agency (DARPA), with the cooperation of the Army at Fort Knox. Training and Doctrine Command (TRADOC) Analysis Command (TRAC) was tasked with the verification and validation (V&V) of SIMNET. The V&V reported here was performed for TRAC. The verification and validation of a portion of the SIMNET-T system reported here yields certain benefits. The V&V process itself has assisted the system designer in making changes to the model. Also, knowledge of the direction and magnitude of the error terms in the SIMNET approximations provides a basis for evaluating impacts on the training and development missions. More importantly, the SIMNET V&V will provide the basis for making the follow-on CCTT system better. Finally, the SIMNET V&V may be setting a standard for the Army's Verification and Validation program. The verification and validation of SIMNET reported here is a supplement to the ongoing program of exception reporting that is provided by SIMNET training participants. Although several significant findings are reported here, the number and severity of problems reflect only the prototype status of the project. Each of the problems appears correctable with relatively small effort.

4501 Chemical Explosions and Explosives

Refer also to citation(s) 5002, 5003, 5216, 5603, 6285, 6304, 6568, 6576

6473 (LA-SUB–94-146-Task-1) **Final report for confinement vessel analysis: Task 1, Correlation of new vessel data with finite element results.** Lewis, B.B. (APTEK, Inc., Colorado Springs, CO (United States)). Los Alamos National Lab., NM (United States); APTEK, Inc., Colorado Springs, CO (United States). 30 Nov 1993. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95001393. Source: OSTI; NTIS; GPO Dep.

Los Alamos performed tests of a modified confinement vessel in November 1992 to gain a better understanding of the response of the confinement vessel. The first test was meant to duplicate, with additional instrumentation, tests done previously for correlation with analysis. Task 1 of Subcontract Number 9-XH3-0607K-1 was the correlation of this new vessel test data with the results of finite element analyses. The authors also examined the data for the other test, which was for optical port development. The tests were numbered H-1573 and H-1562 and were fired on November 9 and 10, 1992, respectively. Test H-1573 was identical to the previous 40 lb tests except that a Burke tube was used to support the explosive charge while the explosive was freely suspended in the earlier tests. The second test, H-1562, was for development of the optical port. In addition to the Burke tube, this test also had additional components on the inside of the ports to protect the windows. The following are conclusions and recommendations drawn from assessment and correlation of tests H-1573 and H-1562: (1) yielding was measured at the bottom of the vessel for these tests; (2) the presence of a support tube in the vessel may have caused focusing of the pressure at the bottom, obscuring the response mechanism thought to have caused yielding in earlier tests; (3) the frequencies predicted using the finite element analysis correlated fairly well with the test results, but the analysis did not predict the yielding measured at the –73 degrees locations; (4) excellent pressure measurements were obtained; (5) better methods of obtaining acceleration data for the windows need to be developed; and (6) the authors believe that the window damage is caused by response of the vessel.

6474 (LA-SUB–94-146-Task-2) **Final report for confinement vessel analysis. Task 2, Safety vessel impact analyses.** Murray, Y.D. (APTEK, Inc., Colorado Springs, CO (United States)). Los Alamos National Lab., NM (United States); APTEK, Inc., Colorado Springs, CO (United States). 26 Jan 1994. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95001394. Source: OSTI; NTIS; GPO Dep.

This report describes two sets of finite element analyses performed under Task 2 of the Confinement Vessel Analysis Program. In each set of analyses, a charge is assumed to have detonated inside the confinement vessel, causing the confinement vessel to fail in either of two ways; locally around the weld line of a nozzle, or catastrophically into two hemispheres. High pressure gases from the internal detonation pressurize the inside of the safety vessel and accelerate the fractured nozzle or hemisphere into the safety vessel. The first set of analyses examines the structural integrity of the safety vessel when impacted by the fractured nozzle. The objective of these calculations is to determine if the high strength bolt heads attached to the nozzle penetrate or fracture the lower strength safety vessel, thus allowing gaseous detonation products to escape to the atmosphere. The two dimensional analyses predict partial penetration of the safety vessel beneath the tip of the penetrator. The analyses also predict maximum principal strains in the safety vessel which exceed the measured ultimate strain of steel. The second set of analyses examines the containment capability of the safety vessel closure when impacted by half a confinement vessel (hemisphere). The predicted response is the formation of a 0.6-inch gap, caused by relative sliding and separation between the two halves of the safety vessel. Additional analyses with closure designs that prevent the gap formation are recommended.

6475 (LA-SUB–94-146-Task-3) **Final report for confinement vessel analysis. Task 3, Analysis of confinement vessel doors.** Lewis, B.B. (APTEK, Inc., Colorado Springs, CO (United States)). Los Alamos National Lab., NM (United States); APTEK, Inc., Colorado Springs, CO (United States). 31 Dec 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95001395. Source: OSTI; NTIS; GPO Dep.

The confinement vessel has five closure doors of two different sizes. The vessel must withstand an initial dynamic load and a quasi-static internal pressure with no leakage of gases through the port seals. Task 3 of the Confinement Vessel Analysis Program was to assess the doors for safety. Of primary concern is the integrity of the seal. This encompasses the structural integrity of the door and nozzle as separate structural elements and the relative motion between the door and nozzle which could cause leakage of gases around the seals. In addition, the authors would like to obtain a better understanding of the effect of the bolt preload, especially as it affects the dynamic response of the structure. The authors explain the objectives of the task in Section 1, describe the models used for the analyses in Section 2, and give results in Section 3. They list conclusions and recommendations in Section 4.

6476 (LA-UR–94-3490) **Explosive performance measurements on large, multiple-hole arrays and large masses of conventional explosive.** McKown, T.O. (Los Alamos National Lab., NM (United States)); Eilers, D.D.; Williams, P.E. Los Alamos National Lab., NM (United States). [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950247–1: 21. annual conference on explosives and blasting techniques and 11th annual symposium on explosives and blasting research, Nashville, TN (United States), 5-9 Feb 1995). Order Number DE95002718. Source: OSTI; NTIS; GPO Dep.

The COntinuous Reflectometry for Radius vs. Time EXperiment (CORRTEX) system was developed by the Los Alamos National Laboratory for determining the energy released in a nuclear explosion by measuring the position of its shock front as a function of time. The CORRTEX system, fielding techniques, and the methods and software for data reduction and analysis were developed over a 15 year period with hundreds of measurements made on nuclear tests and high explosive experiments. CORRTEX is a compact, portable, fast-sampling, microprocessor-controlled system, based on time domain reflectometry, requiring only a 24 volt power source and a sensing element. Only the sensing element (a length of 50 ohm coaxial cable) is expended during the detonation. In 1979, the CORRTEX system was shown to be ideally suited for chemical explosive performance measurements. Its utility for diagnosing chemical explosives was further demonstrated with successful measurements on large multiple-hole chemical shots in rock quarries and strip mines. Accurate timing of the detonation of sequenced or ripple fired arrays, as well as data characterizing the initiation, explosive performance and detonation anomalies are obtained. This information can serve as the basis for empirical or modeled improvements to blasting operations. A summary of the special CORRTEX features and well developed analysis techniques together with the experiment designs, data, and conclusions regarding the measurements and explosive performance from several array detonations and the Chemical Kiloton Experiment, 2.9 million pounds of an ammonium nitrate-fuel oil (ANFO) and emulsion blend conducted on the Nevada Test Site in 1993, are presented.

6477 (LA-UR–94-3977) **Techniques for classifying acoustic resonant spectra.** Roberts, R.S.; Lewis, P.S.; Chen, J.T.; Vela, O.A. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9411159–1: Asilomar/signals, systems and computers, Pacific Grove, CA (United States), 1 Nov 1994). Order Number DE95003672. Source: OSTI; NTIS; GPO Dep.

A second-generation nondestructive evaluation (NDE) system that discriminates between different types of chemical munitions is under development. The NDE system extracts features from the acoustic spectra of known munitions, builds templates from these features, and performs classification by comparing features extracted from an unknown munition to a template library. Improvements over first-generation feature extraction template construction

and classification algorithms are reported. Results are presented on the performance of the system and a large data set collected from surrogate-filled munitions.

6478 (SAND–95-8202) **Supercritical water oxidation of ammonium picrate.** LaJeunesse, C.A.; Mills, B.E.; Brown, B.G. Sandia National Labs., Livermore, CA (United States). Nov 1994. 30p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004194. Source: OSTI; NTIS; GPO Dep.

This study demonstrates the feasibility of using supercritical water oxidation to destroy ammonium picrate. Analyses of reactor effluent composition at various temperatures, residence times, and oxidant concentrations were used to design an improved reactor configuration for achieving destruction with minimum corrosion. The engineering evaluation reactor, a room-sized laboratory scale reactor, was reconfigured to incorporate this design change. Destruction of ammonium picrate with minimized corrosion was demonstrated on this reconfigured reactor. Factors that must be considered in scaling up to pilot plant size are discussed.

4502 Nuclear Explosions and Explosives

Refer also to citation(s) 6557, 6568, 6576, 6604, 6936

6479 (CONF-9309103–Vol.1, pp. 3-9) **Did the nuclear test moratorium of 1958 teach us anything?.** Brownlee, R.R. (Raytheon Services of Nevada, Las Vegas, NV (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

The history of our behavior during and after the nuclear test moratorium could be mined to the benefit of decision makers, planners, and containment staffs. Some of the lessons learned are reviewed. Given the characteristics of bureaucracies, and the power of the concept of institutional survival, lessons of the past are not apt to be applied with much success. Nevertheless, people knowledgeable about containment are vital to the national interest, and must find a way to keep the science alive.

6480 (CONF-9309103–Vol.1, pp. 11-46) **The Containment Evaluation Panel: Background and foreground.** Carothers, J. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

This article describes nuclear explosion containment from a historical and political aspect. The purpose is to discuss the Containment Evaluation Panel and its effectiveness.

6481 (CONF-9309103–Vol.1, pp. 47-83) **My thoughts about containment.** Duff, R.E. (S-Cubed, La Jolla, CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

An admittedly speculative overview of nuclear test containment philosophy and tunnel stemming predictive capability is presented. The main conclusions are that non-homogeneous rock motion produced by an underground explosion produces conditions where the residual stress field should not be expected to form with the magnitude, at the location, or at the time predicted by continuum models. Such non-homogeneous ground motions have been observed post-shot both along pre-existing fault or bedding planes and along planes not mapped pre-shot as unusual. Current pre-shot continuum analyses do not consider the possible impact of non-homogeneous ground motion on stemming plug formation. Recommendations for alternative calculational procedures, such as three-dimensional discrete element analyses based on measured block interface mechanical properties, are presented. It is recommended that, until these new analyses techniques are verified and shown to provide meaningful quantitative predictions, future test designs should continue to be developed primarily from empirical data and other experience.

6482 (CONF-9309103–Vol.1, pp. 85-119) **Site selection and containment evaluation for LLNL nuclear events.** Olsen, C.W. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

During approximately the past decade, the site selection process at LLNL has evolved as the Test Program needs and resources have changed, containment practices have been modified, and the DOE and other regulatory agencies have become more restrictive. Throughout this period the Containment Program and the Field Operations Program at LLNL have managed a cooperative effort to improve site selection. The site selection process actually is three interrelated tasks, namely, selection of a stockpile hole for a specific nuclear test, selection of a drill site for a stockpile hole, and selection of a new drill site for a specific test. Each proposed site is carefully reviewed for known or projected geologic structure and medium properties, nearby holes, containment experience in the region, likelihood of drilling problems, programmatic need for a given depth of hole, and scheduling of Test Program events and resources. By using a data bank, general knowledge of the Nevada Test Site (NTS) geology, and other information sources, as well as background in drilling large diameter holes at the NTS, LLNL has been able to optimize the use of NTS real estate and programmatic resources. The containment evaluation of a site is facilitated by considering the location before the hole is drilled. The authors discuss imposed restraints and criteria and guidelines for site selection and assignment of events to specific holes, along with the factors that influence selection of a Working Point (WP) depth. Since siting and containment evaluation are strongly related, most major factors related to the containment evaluation process are also reviewed.

6483 (CONF-9309103–Vol.1, pp. 121-128) **Experimental determination of containment versus burial depth for explosions in sand.** Schmidt, R.M. (Boeing Defense & Space Group, Seattle, WA (United States)); Voss, M.E. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

This paper describes an experimental method for determining the dispersion of the source material following a buried explosion in sand. Using the established technique of subscale centrifuge modeling, both visual and chemical analysis using elements of the explosive as a tracer results in a dispersion pattern as a function of depth of burst. It is possible to directly measure the percentage of the source material which remains buried and the percentage that settles on the surface close to ground zero. It is not possible, given size constraints of laboratory samples, to measure dispersion of material that becomes airborne and is spread by atmospheric currents. This necessitated choosing depths of burst well past optimum, where crater volume is relatively small, and most of the source material remains below the ground surface.

6484 (CONF-9309103–Vol.1, pp. 129) **Scaling of deeply buried explosions.** Housen, K.R. (Boeing Defense & Space Group, Seattle, WA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

The containment of underground explosions involves many of the same problems encountered in the related problem of explosive cratering. In particular, for both cases, field tests are often

conducted with yields and burial depths vastly different from those of actual interest. Therefore, the question of scaling must be addressed before field results can be usefully applied. A series of experiments were performed to determine the scaling exponent for large yields, i.e., in a regime in which strength and atmospheric pressure effects are absent. To accomplish this, the tests were conducted in cohesionless dry sand under near-vacuum conditions. Both the charge burial depth and the centripetal acceleration (i.e., scaled yield) were varied. These tests provided the first results in a purely gravity dominated regime with a significant variation (a factor of 600) in the explosive yield. Plots of the scaled crater volume, $V/W^{3/n}$ versus the scaled burial depth, $d/W^{1/n}$ showed that the exponent n is 3.7, which is significantly larger than the value of 3.4 deduced from field tests, yet still below the quarter-root value of 4. Subsequent experiments have shown that, when ambient pressure effects are important, the scaling exponent is smaller than its gravity-regime value. In particular, for 1-atm conditions, the exponent should be in the range of 3.4 to 3.5 for yields in the range of typical field tests, i.e., tons to kilotons. These results suggest that n = 3.4 is not appropriate for large yields.

6485 (CONF-9309103–Vol.1, pp. 133-151) **Low-yield event design and performance review.** Peterson, E. (S-Cubed, La Jolla, CA (United States)); Ristvet, B.; Lacomb, J.; Harris-West, B.; Metcalf, R.; Patch, D. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

The low-yield horizontal-line-of-sight (HLOS) effects tests conducted by DNA use a HLOS drift containment system design that is different from that used on previous standard-yield tests. Mechanical pipe closures for a low-yield test include the fast-acting-closure (FAC), gas-seal-auxiliary-closure (GSAC) and tunnel-and-pipe-seal (TAPS) with the closure nearest the working point (i.e. FAC) designed to also serve as a stemming bulkhead. Alternate lengths of rock-matching and super-lean grouts comprise the HLOS drift stemming column. In contrast, previous standard-yield tests used a modified-auxiliary-closure (MAC), GSAC and TAPS. In that design, the closure nearest the working point (i.e. MAC) was not designed, or positioned, to serve as a stemming bulkhead. In addition, the standard-yield stemming column consisted of a single length of rock-matching grout beginning in the region of the working point followed by a length of superlean grout extending to the MAC. Containment of the low-yield events has been outstanding. There has been no accidental release of radioactivity to the atmosphere and no leakage to the tunnel complex, Vessel 3. Operationally insignificant quantities of activity have been detected in the tunnel complex, Vessel 2, on a few events and some minor quantities of cavity gas have, on occasion, seeped into the LOS pipe. All low-yield tests have qualitatively similar containment system designs. However, overall test details are unique with design differences associated with device yield, test objectives, site geology, etc. In total, twenty three design features have been identified. These design features are examined for differences that may correlate with observed seepage to the HLOS pipe and/or Vessel 2 of the tunnel complex.

6486 (CONF-9309103–Vol.1, pp. 153-178) **Initial cavity-growth/pipe-closure phenomena.** Lie, K. (S-Cubed, La Jolla, CA (United States)); Higginbotham, M.; Peterson, E. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

During the initial cavity formation process the ground-motion-induced closure of the reverse cone and line-of-site (LOS) pipe results in the formation of a high density region (e.g. plug) that blocks the flow of cavity gas into the pipe. However, the dynamic closure process generates high energy material with the potential to flow down the LOS pipe and to thereby affect further pipe closure and/or possibly impact mechanical closures. The reverse cone is therefore designed to generate a competent plug while minimizing damaging pipe flow. Analysis of the onset of the closure processes have to date been performed using a Lagrangian code initially and then coupling those results to the Eulerian SOIL code. Results of those calculations are generally in agreement with existing pipe flow measurements to the extent they show both a first and second flow and, in most cases, they are qualitatively consistent with observed changes in flow amplitude associated with design modifications of the reverse cone and LOS pipe. However, the calculations which describe the first few milliseconds of the closure process tend to over-estimate the plasma flow magnitudes and show no evidence of a jetted liquid flow that has at times been suspected of impacting the mechanical closures.

6487 (CONF-9309103–Vol.1, pp. 179-188) **Do analytic models of near source pipe flow compare to measurement?.** Higginbotham, M.L. (S-Cubed, La Jolla, CA (United States)); Sandmann, R.A. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

For most DNA events Sandia National Laboratory has fielded pressure and time-of-arrival (TOA) measurements along the line-of-sight (LOS) pipe and in the surrounding stemming. In recent years useful data return has increased dramatically. As this technology has progressed the ability to make measurements closer and closer to the source has become feasible. The principal measurement instruments include; SLIFER cables to record shock TOA versus position, ported pressure gauges installed on the LOS pipe wall to measure the dynamic pressure of energetic LOS plasma flow, and piezioelectric stress gauges embedded in the stemming outside the LOS to measure strong shock pressures in the hundreds of kilobar range.

6488 (CONF-9309103–Vol.1, pp. 189) **The second pipe flow in the line-of-sight pipe.** Bergstresser, T. (Sandia National Lab., Albuquerque, NM (United States)); Bass, R.C. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

Explosion-generated flow in a horizontal line-of-sight (LOS) pipe is of distinctive concern to the containment community because it has been and can be a threat to the closures. The authors have evaluated the data from measurements on pipe flow in Defense Nuclear Agency-sponsored, low-yield events of the past 17 years. Most of the measurements have been made using the fluid-coupled plate gauge, with the force-plate installed flush with the interior surface of the pipe so as to measure the side-on pressure. The data set is limited to measurements in front of the muffler, if any, and away from the closed FAC (fast-acting closure). Present interest is in the second pipe flow, which originates in the crushing of the LOS pipe by ground shock. This causes jetting of material from the pipe and surrounding grout. A summary of these data is presented. They find that the peak pressures of most events, as a function of yield and range, are well-fitted by a simple formula. The outliers are discussed. In particular, the internal helix is seen to be effective in reducing the threat to closures. Similar information on the first pipe flow has already been reported. They briefly review this flow, adding data from recent events.

6489 (CONF-9309103–Vol.1, pp. 191-224) **Close-in shock wave diagnostics on MIDDLE NOTE and MISSION CYBER.** Duff, R. (S-Cubed, La Jolla, CA (United States)); McKown, T.; Eilers, D.; Storey, W.; Bass, R. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

There has long been interest in testing and confirming the calculations used to design closure systems for DNA line-of-sight (LOS)

experiments. Since the regime of relevance of these calculations is one of extreme conditions, conducting meaningful experiments is very difficult and quite expensive. As a result, relatively little data exists describing the initial stemming plug formation process. Complex arrays of CORRTEX and SLIFER cables were emplaced on MIDDLE NOTE and MISSION CYBER near the Box-A, reverse cone, and LOS pipe. These data were intended to provide heavily redundant measures of close-in shock propagation at several angles from the vertical and to thereby provide measurements that would constitute a limited test of calculations of the initial reverse-cone/pipe-closure process. A preliminary analysis of some of the data available is presented.

6490 (CONF-9309103–Vol.1, pp. 227) **The size of underground cavities formed by nuclear devices: Implications of point-source solutions for geological materials.** Holsapple, K.A. (Univ. of Washington, Seattle, WA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

Containment depends on knowledge of the size of a cavity created by a given event. Estimates are determined by the CEP equation or other scaling laws, and by prior experience. Scaling laws can be determined by point-source solutions for appropriate geological materials. The authors present point-source solutions for porous geologic materials based upon the work of Kompaneets. A discussion and complete results of the point-source solutions and the resulting scaling laws are presented. Application to the cavity formation problem gives scaling laws with a material property dependence. Implications with regard to cavity size scaling are discussed. A specific form like the CEP equation, but with exponents depending on material properties, and especially on the porosity, is obtained.

6491 (CONF-9309103–Vol.1, pp. 229-237) **GALENA pressure history and a proposed sensor for mean residual stress.** Hudson, B. (Lawrence Livermore National Lab., CA (United States)); Pratuch, S.; Heinle, R.; Hatch, M.; Stubbs, T. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

A new, light-weight, inexpensive cavity pressure system was fielded on the GALENA event. This system included a high pressure liquid pump (2500 psi, 1.5 ml/min.), a high-pressure hose extending from the instrumentation package to about 100 feet above the working point, and a stainless steel capillary tube extending from there into the expected cavity region. The system was pressurized to about 1500 psia before detonation. The resulting data suggest pressure equilibrium with the cavity region was reached within 10 s of detonation, and the subsequent pressure history, ranging from above 500 down to 40 psia, appears to be a valid measure of cavity pressure. The data acquired before 1 s suggest that the high-pressure hose performed as a pressure sensor as the initial shock wave passed over it. The authors plan to use a system similar to the one described above, without the capillary tube extending to the working point region, to sense mean residual stress on future events.

6492 (CONF-9309103–Vol.1, pp. 239-248) **Cavity gas pressure measurements on diamond fortune.** Smith, C.W. (Sandia National Labs., Albuquerque, NM (United States)); Breeze, S.P. Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract AC04-76DP00789. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

Five measurements were made of the gas pressure in the cavity as a function of time on the DIAMOND FORTUNE event. The measurements were obtained with a fast and slow blowdown technique; an additional transducer on the cavity side of the explosive valve provided valuable data. Data from three of the five transducers are nearly coincident; data from the other two show temperature-related shifts. The timeframe of the credible measurements extends from 0.1 second to four hours. The pressure at two seconds was 2,100 kPa (300 psi). On the logarithmic time scale this level decays monotonically to 210 kPa (30 psi) at 1000 seconds. During the next decade of time the cavity pressure approached atmospheric pressure. Over the initial few seconds the measured amplitude is close to the S-Cubed prediction; with increased time the measured pressure decays at a faster rate.

6493 (CONF-9309103–Vol.1, pp. 251-257) **Containment and safety data acquisition system for the LYNER complex.** Deupree, R.G. (Los Alamos National Lab., NM (United States)); Oblad, R.; Turner, W.J.; Blain, P.; Khalsa, N. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

LYNER is an underground tunnel complex constructed near the U1 a shaft designed to perform weapons related tests. A number of measurements are planned to obtain containment, environment, and safety related information. Unlike Los Alamos vertical weapons tests where data collection is performed from a trailer at the surface, containment-related data collection instrumentation will be installed in an underground alcove at one end of the complex. The authors describe the measurements they plan to make, how they expect to make them, the hardware involved, and the process by which the selection was made.

6494 (CONF-9309103–Vol.1, pp. 259-304) **Three-dimensional porous flow calculations of the LYNER concept.** Trent, B.C. (Los Alamos National Lab., NM (United States)); Travis, B.J. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

The nature of an underground testing facility for multiple-use, low-yield underground explosions is inherently three-dimensional. The boundary conditions from the blast and those from the main access drift are essentially orthogonal. To address the containment-related problems and possible solutions of the LYNER facility, an extensive series of 3-D porous flow calculations was performed. First, access drift and room/cavity dimensions were determined. Next, specific containment features, such as massive grout plugs, were incorporated into the analysis. Material properties for all geologic and containment related materials were then established. Finally, realistic pressure and tracer (radiation) boundary conditions were applied to the cavity walls. The resulting time-dependent distributions of gas-borne contamination established a baseline case. Then, several different remedial actions were investigated numerically, including time-dependent pressurization of the access drift and the emplacement of low permeability (but still leaky) doors to maintain a pressure gradient away from the "clean" access regions. The utility of such a computational capability has been to provide (at a very low cost) an "order-of-magnitude" estimate of compressed air requirements and "stand-off" distances to assure that the underground test facility can be operated with minimal risk of contamination of the entire complex. By using a porous flow code that had been tested and validated for containment-related problems (TRACR3D), the results are reasonably believable, subject to the assumptions and limitations of such an analysis. Also, the use of state-of-the-art, three-dimensional graphics capabilities, provided a unique opportunity to "see into" the problem and numerically investigate novel solutions, based on these insights which are unavailable in a two-dimensional environment.

6495 (CONF-9309103–Vol.1, pp. 305-337) **Containment related phenomenology from chemical kiloton.** Rimer, N.

(S-Cubed, La Jolla, CA (United States)); Proffer, W.; Halda, E.; Nilson, R. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 1.* 336p. Order Number DE95001257. Source: OSTI; NTIS; INIS; GPO Dep.

CHEMICAL KILOTON is a DOE/LLNL verification/nonproliferation test located in zeolitized, saturated tuff in the U12n.25 drift near MISTY ECHO, MINERAL QUARRY, and HUNTERS TROPHY. The source consists of 2.9 million lb.. (approx. 1315 metric tons) of a 50/50 ANFO/emulsion mix (10^{12} calorie energy release) in a 50 ft. diameter by 17 ft. deep "tuna can" shaped cavity (volume of approx. 980 m^3). This paper summarizes the results of a series of one- and two-dimensional calculations, which were made for DNA, of the ground motions, residual stresses, and potential for hydrofracture into an open alcove located only 52 m from the cavity wall. The numerical predictions, made using tuff material properties from the nearby MISTY ECHO event, are to be compared to anticipated SNL measurements in order to validate the computational damage models for tuff used for simulations of nuclear events. These SNL measurements to late times of both radial and hoop stress components (at peak stress levels of 0.5-1.0 kb) are intended to provide direct evidence of residual stresses in this tuff.

6496 (CONF-9309103–Vol.2, pp. 3-19) **Testbed design and analytic evaluation of a proposed very low yield DNA horizontal line-of-sight event.** Higginbotham, M.L. (S-Cubed, La Jolla, CA (United States)); Dismukes, C.R.; Sandmann, R.A. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Since the last symposium the DNA has considered the feasibility of a very low yield SREMP Horizontal Line-Of-Sight (HLOS) event. S-Cubed was asked to participate in the design and evaluation of early test-bed concepts. Non-traditional designs are required for a very low yield event because achieving total containment using mechanical closures alone is mandatory. The design goal was to decrease the threats on the closure hardware to ensure their survival. In the earliest phase of the project, attention was focused on the region within a few meters of the source. Initial designs included unusual geometries and special materials whose purpose was to divert expanding device products away from the open LOS pipe. The plan was to use the diverted energy to obliquely close the LOS pipe well ahead of the device explosion products moving toward the LOS. Although progress was made and workable designs seemed conceptually feasible, the close proximity of the source and LOS resulted in designs that were extremely sensitive to device characteristics.

6497 (CONF-9309103–Vol.2, pp. 21) **Response of steel vessels and cavity liners to dynamic loading.** Snell, C.M. (Los Alamos National Lab., NM (United States)); Swift, R.P.; Marusak, N.L.; Hill, L.R. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The use of steel vessels to fully contain explosion products is one approach for conducting high-explosive hydrodynamic experiments and zero-yield or low-yield nuclear tests. Such vessels could be free-standing, located above ground or underground, or a prestressed liner in a rock cavity utilizing the rock as an integral part of the containment system. The authors have performed a suite of one-dimensional calculations to define the dynamic response and assess containment capability of typical steel vessels. Performance was assessed as a function of the following parameters: (1) scale vessel radius and wall thickness; (2) energy source type, i.e., high-explosive and nuclear; (3) initial air pressure inside the vessel; (4) elastic and elastic-plastic behavior of the vessel; and (5) external confinement, i.e., no confinement, soft rock, and hard rock. The energy source was modeled as a uniform "pill" of the appropriate mass and energy density. The pill approximation is shown to agree with more detailed source calculations, indicating that it is adequate for the regime of interest for the containment vessel response. Calculational results are presented in the form of scaled peak strains in the vessel wall versus energy density of the source. They find that impulsive loading tends to dominate the response for massive energy sources, e.g., high-explosive (HE), and for large initial air mass in the vessel, e.g., 1 atmosphere. The late-time-quasi-static pressure becomes more important for low-mass nuclear sources and near-vacuum conditions. Peak strains are smaller for nuclear sources than for HE sources, and are significantly reduced by evacuating the vessel. Confining the vessel with rock also reduces the peak strains with best results obtained for hard rock backing. The rock confinement also serves to dampen late-time ringing of the vessel. This is important for asymmetric loading conditions and for multidimensional vessel designs.

6498 (CONF-9309103–Vol.2, pp. 23-43) **Canonical wall loading functions for decoupled cavities and containment vessels.** Snell, C.M. (Los Alamos National Lab., NM (United States)); Swift, R.P.; Marusak, N.L.; Spillman, G.R. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Airblast loading of a cavity wall by a nuclear or high-explosive detonation is of interest for containment of low-yield untamped explosions, dynamic response of containment vessels or liners, seismic decoupling by cavities, and other applications. Recent studies of the LYNER test concept and other cavity-related designs have highlighted the fact that there is no complete and internally consistent set of airblast loading functions to characterize the expected loading over a broad range of peak pressures. For cavity radii larger than about 10-15 $m/kt^{1/3}$, displacement of the wall during the loading pulse is generally small relative to the cavity radius. In this regime, the wall can be treated as a fixed or rigid boundary for the purpose of calculating the reflected airblast pressure history. The authors have performed a series of one-dimensional spherically symmetric calculations for typical nuclear and high-explosive energy sources in air-filled cavities with radii of 15 $m/kt^{1/3}$ to 295 $m/kt^{1/3}$. This encompasses a range of peak reflected pressures at the cavity wall from approximately 1000 MPa to 0.1 MPa. The calculations were run for durations of at least 0.07 $sec/kt^{1/3}$ for the smallest cavities, up to 0.9 $sec/kt^{1/3}$ for the largest cavities. This time period includes up to 25 cavity gas "bubble-bounce" oscillations for the smallest cavities. The calculational results were validated by comparison with nuclear and high-explosive free-air and reflected airblast data. These pressure-versus-time histories provide a covenient and accurate set of loading profiles that can be used for containment and cavity decoupling studies.

6499 (CONF-9309103–Vol.2, pp. 45-58) **Containing repeated low-yield nuclear explosions in steel-lined rock caverns.** Heuze, F.E. (Lawrence Livermore National Lab., CA (United States)); Swift, R.P.; Hill, L.R.; Barrett, W.H. Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

This work involved the response of a liner-bolt system installed on the wall of the DIAMOND FORTUNE cavity, a 22-m diameter nearly semi-spherical chamber in tuff, at the Nevada Test Site. DIAMOND FORTUNE is a low-yield nuclear test of the Defense Nuclear Agency which was performed in April, 1992. A 1.4-m square, 2.5-cm thick steel plate was anchored by 9-m long bolts: four 2.5-cm diameter bolts at the corners and a 5-cm diameter bolt at the center. The bolt ends daylighted in a tunnel surrounding the cavity, and were tensioned from there. The system was equipped with 20 data channels for strain, acceleration, contact pressure, and temperature. The authors related the thermal analyses and the

3-dimensional dynamic analyses performed for this project, and they present the test results which indicated the excellent response of this system to the high dynamic loads and temperatures.

6500 (CONF-9309103–Vol.2, pp. 61-85) **Distinct element modeling of late-time containment phenomena.** Proffer, W.J. (S-Cubed, La Jolla, CA (United States)); Halda, E.J. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Ground motion predictions for underground nuclear tests are traditionally performed using finite difference models based on continuum mechanics. Calculations performed with these models show that in tamped events the plastic work done on the surrounding rock during cavity growth should produce compressive residual hoop stresses which are large enough to contain the cavity gases. Small scale laboratory and field experiments have verified that such residual stress fields are formed by explosions conducted in homogeneous materials. However, the few successful measurements obtained within the severe environments produced by nuclear events suggest that the actual residual stresses may be weaker than calculated or may decay very rapidly. It has been conjectured that the absence or reduction of residual stresses might be a consequence of the faults and joints which are present in the geologic host medium. Shear displacement of faults and joints, sometimes exceeding a meter, are routinely observed on reentry. Since these non-homogeneous discrete motions occur within the confines of the residual stress fields calculated by the continuum models, they clearly have the potential to significantly alter the formation of a confining stress field.

6501 (CONF-9309103–Vol.2, pp. 87-123) **Calculations of NTS residual stress measurements and some implications for models and material properties.** Rambo, J. (Lawrence Livermore National Lab., CA (United States)); Rimer, N. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Residual stress measurements have been obtained from several events, in particular LLNL's QUESO and ORKNEY in NTS Area 10, and DNA's HUNTERS TROPHY event in Area 12. These events employed different types of stress gauges to measure radial- and tangential-stress components. The Area 10 events show the development of compressive residual stresses. For ORKNEY, with a working point in alluvium, just above the alluvium/tuff interface, radial- and tangential-stress gauges were located at 36 and 44 m range, respectively. Since direct comparisons between the two stress measurements are complicated by stress attenuation across the 6 m separation between the two gauges, ground motion calculations were employed to aid in the evaluation of the measurements. The calculated and measured peak-stress attenuations were found to be consistent as were the times of residual stress setup and rebound, also inferred from velocity gauges located further from the working point.

6502 (CONF-9309103–Vol.2, pp. 125-144) **Calculations of the FLAX events with comparisons to particle velocity data recorded at low stress.** Rambo, J. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The FLAX event, fired in 1972, produced two particle velocity data sets from two devices in the same hole, U2dj. The data are of interest because they contain verification of focusing of a shock wave above the water table. The FLAX data show the peak velocity attenuation from the device buried in saturated tuff are different from those emanating from the upper device buried in porous alluvium. The attenuations of the peaks are different in regions traversed by both waves traveling at the same sound speed and measured by the same particle velocity gages. The attenuation rate from the lower device is due to 2-D effects attributed to wave focusing above the water table and is a feature that should be captured by 2-D calculations. LLNL's KDYNA calculations used for containment analyses have utilized a material model initially developed by Butkovich, which estimates strength and compressibility based on gas porosity, total porosity, and water content determined from geophysical measurements. Unfortunately, the material model estimates do not correctly model the more important details of strength and compressibility used for matching the velocity data. The velocity gage data contain information that can be related to the strength properties of the medium, provided that there are more than two gages recording in the stress region of plastic deformation of the material. A modification to Butkovich's model incorporated approximate strengths derived from the data. The mechanisms of focusing are discussed and incorporate additional information from the TYBO event.

6503 (CONF-9309103–Vol.2, pp. 145) **Residual stress implications due to variations of yield and depth-of-burial of two nearly simultaneous explosions.** Rambo, J.T. (Lawrence Livermore National Lab., CA (United States)); Moss, W.C.; Levatin, J.L. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Underground tests of two nearly simultaneous explosions in the same vertical hole have often been done by placing a very low yield device below a normally buried higher yield device. However, there are economics to detonating higher yield combinations in the same hole and especially to placing the lower yield device above a normally buried higher yield device. The authors have calculated the residual stress fields (RSF) for various combinations of yields and vertical device separations where the lower yield device was placed above the higher yield device. Two types of scale depth-of-burial (SDOB) criteria and various separation criteria were considered. Initially, large separation distances greater than four times the lower final-cavity radius were used to prevent contamination of tracers (nuclear chemistry requirement). Possible atypical collapse scenarios provide additional constraints that restrict the upper device to a SDOB equal to or greater than 250 $m/kt^{1/3}$. These calculations showed a poor RSF. When the nuclear chemistry constraint was relaxed (i.e., 1,2, and 3 final-cavity radii separation), a better RSF was calculated. However, for smaller separations, previous work suggests these closely spaced devices can develop high cavity pressures. Cavity merging, which could occur, but was not included in previous calculations, would alleviate the high cavity pressures. Recent calculations with closely spaced devices used a separation of 40 m, (approximately a diagnostic canister length), with various yield combinations surrounded by a generic NTS flats tuff. The close spacing required software development to merge cavities and is discussed. Calculations that demonstrate weaknesses in the RSF are shown. The calculations provide some general emplacement guidelines but site-specific material properties and geologies of actual events should be calculated for an appropriate containment analysis.

6504 (CONF-9309103–Vol.2, pp. 149-174) **Recent observations of mechanical properties and microstructure of shock-conditioned tuff.** Martin, J.W. (Univ. of Utah Research Park, Salt Lake City, UT (United States)); Fredrich, J.T.; Green, S.J. Lawrence Livermore National Lab., CA (United States). [1993]. Contract DNA 001-90-C-0169. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

"Shock-Conditioning" as used herein is a term used to indicate changes in geologic material resulting from the passage of an

explosively driven stress wave through the material. A detailed understanding of shock-conditioning may aid the containment design of underground nuclear tests, assessment of the vulnerability of underground structures, design of tunnel support, and development of constitutive models for shock damaged media. This paper documents the results of a research effort which focused on three related issues: (1) the effect of shock-conditioning on the physical and mechanical properties of NTS tuff; (2) the identification and quantification of microstructural damage in shock-conditioned tuff; and (3) the comparison of microstructural damage resulting from field (dynamic) versus laboratory (quasi-static) loading. Laboratory and microscopy studies performed on two suites of tuff retrieved from the P-tunnel complex prior to and immediately following the DISKO ELM event reveal that: (1) the shock-conditioning caused no significant change in physical properties (i.e. porosity and saturation); (2) the shear strength and the stiffness moduli of shock-conditioned tuff are significantly lowered for peak stress of 200 MPa and higher; (3) this degradation is believed to be associated with measurable microstructural damage consisting of new microcracks; (4) the microstructural damage in the form of microcracks and crushed pores which is present in tuff exposed to approximate shock levels of 200 MPa and greater increases with shock level; (5) the degradation caused by shock-conditioning (i.e. dynamic loading) is greater than that caused by quasi-static laboratory loading following the postulated field-loading path; and (6) the shock-conditioned tuff shows a more homogeneous distribution of new microcracks than the laboratory-loaded samples which exhibit strain localization for samples loaded to approximately the same peak radial stress.

6505 (CONF-9309103–Vol.2, pp. 175-190) **Properties of NTS tuff.** Thummala, V. (Materials Testing Lab., Mercury, NV (United States)); Moore, J.G.; Aamodt, J.E. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The Raytheon Services Nevada (RSN) Materials Testing Laboratory (MTL) located at the Nevada Test Site (NTS) in Mercury, Nevada has been conducting rock testing for DOE, DOD/DNA, LLNL, and LANL and for other special projects. Various NTS tuff (a volcanic rock formation) samples were tested using different methods over the years. Welded and non-welded tuff physical, mechanical, hydrologic and thermal properties are presented. The properties are sorted and summarized according to the general NTS tuff stratigraphic units. Drill holes UE19P, UE18E and samples from G-Tunnel rock property summaries and general test methods are discussed.

6506 (CONF-9309103–Vol.2, pp. 191-199) **Dynamic response of PCGC-1(O) grout.** Felice, C.W. (Mission Research Corp., Salt Lake City, UT (United States)); Ristvet, B. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents the results from a limited series of split-Hopkinson pressure bar (SHPB) experiments on PCGC-1(O) grout. The purpose of the experiments was to qualitatively observe the damage induced in the grout specimens due to the dynamic, high strain rate load. Besides the qualitative observations, stress-time data are presented and compared with the response obtained under static loads. In a traditional SHPB experiment, the load is generated by the impact of a projectile against the incident pressure bar. Instead of a projectile, the loading pulse in these experiments was initiated by an explosive. The explosive detonation produces a half sine wave pulse shape. The pulse is assumed to be one-dimensional, elastic and nondispersive. The explosive consisted of a blasting cap with a 0.4 gram base charge of PETN plus a 0.5 gram booster of PETN. The explosive produced a nominal incident stress of 250 MPa. The specimens were prepared from tube samples of PCGC grout supplied by the U.S. Army Engineers Waterways Experiment Station. The tube samples were nominally 50 mm in diameter. The SHPB specimens were cored to be the same diameter as the pressure bars and end ground to produce three nominal length/diameter (l/d) ratios; 0.2, 0.5 and 1.0. Two specimens were prepared at each l/d ratio. Qualitatively, the observed behavior ranged from pulverizing a zone around the edge of the specimens with the smallest l/d ratio, to slabbing at the intermediate l/d, and finally axial splitting of the specimens with the l/d ration of 1.0. The axial splitting was similar to what is observed in a static unconfined compression test.

6507 (CONF-9309103–Vol.2, pp. 203-208) **YOCOL measurement system for cavity collapse.** Deupree, R.G. (Los Alamos National Lab., NM (United States)); Turner, W.J.; Blain, P.; Flores, P.; Khalsa, N.; Macy, D. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

There are currently two ways in which the process of cavity collapse is measured on Los Alamos National Laboratory nuclear weapons tests: (1) using backfill packages to measure the gas pressure and radiation (and infrequently the acceleration) in the stemming material, and (2) using CACOL units to measure the subsurface breaking of coaxial cables. Both of these are indirect measurements of cavity collapse and occasionally give incompatible results. This has led to the devising of a more direct measurement of the stemming motion with a technique called YOCOL. The experiment follows the motion of a weight at the end of a wire from a linear transition transducer, which is expected to be tightly coupled to the motion of the stemming material.

6508 (CONF-9309103–Vol.2, pp. 209) **A radio frequency interferometer (RIF) system.** Goldwire, H.C. Jr. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The authors describe a radio frequency interferometer (RFI) system developed and tested by Lawrence Livermore National Laboratory over the last several years. The basic theory of operation, sample data, and analyzed results are presented and compared to results obtained by conventional TDR means (CORRTEX). A typical shock location measurement used for hydro-yield determination or for energy flow diagnostics comprises a coaxial sensing cable extending from the detonation region to a CORRTEX recording instrument. The single digitizer-based RFI system uses an identical sensing cable installation technique. Recording equipment consists of a CAMAC digitizer module, which produces a sinusoidal probing signal (the signal sent downhole) for each sensing channel (cable), while also coherently sampling the phase of the reflected signal. Each channel is recorded using a single digitizer, providing maximal temporal and spatial resolution, but independent of channel gain or quadruture errors inherent to dual digitizer systems. Interpolation software with suitable look-ahead logic permits determination of complete quadruture information using a single digitizer. This RFI system provides several times better spatial resolution and two orders of magnitude better temporal sampling density than does CORRTEX. It also is less susceptible to electromagnetic pulse distortion and provides a direct means for identifying (and rejecting) any data so contaminated.

6509 (CONF-9309103–Vol.2, pp. 213-224) **Review and analysis of stemming practices at LLNL with consideration of slumping phenomena.** Cornell, R.H. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear*

explosions. Volume 2. 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Established LLNL practices for stemming and granular materials do not seem to be completely based on analytical or measured criteria. However, data from field experiments and analytical work by a number of investigators indicate that the established standards are conservative regarding stemming-induced over-pressure and granular stemming flow past restrictive annuli. Experimental data indicates that the falling speed of granular stemming is materially less than the expected terminal velocity. This implies the existence of significant wall energy losses for falling stemming. It is difficult to assess how stemming rates effect the potential of slumping. Increasing the stemming rate has been observed to increase the emplaced bulk density of the stemming bed. Higher bulk densities reduce the potential size of a slump. However, increased stemming rate increases downhole air pressure. Increased air pressure is though to be a factor in the production of slumps. These competing characteristics form a subject for further study and experiment. The need exists to develop a method for selecting an optimum stemming rate that will minimize or eliminate slumping potential while still keeping within maximum pressure and restricted area flow allowances.

6510 (CONF-9309103–Vol.2, pp. 225-241) **Polyurethane foam cable bundle block.** Mercier, J.A. (Lawrence Livermore National Lab., CA (United States)); Cornell, R.H.; Pratuch, S.M.; Lundberg, A. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Blocking the flow of radioactive gas in the emplacement hole requires attention to three items: the stemming materials, the cables, and the spaces between the cables. This paper deals with an improvement in the latter; that is, filling the spaces between the cables and, thus, forming a bundle block. The authors have tested a two-part polyurethane foam in the field with apparent success. Field tests included recovery of sample cable bundles from a nuclear test in a tunnel. The foam creates a bundle block that survives the shock loading and improves the resistance to gas flow by as much as a factor of 3.

6511 (CONF-9309103–Vol.2, pp. 243-273) **Field permeability and strength tests of LANL grout and TPE plugs.** Trent, G.C. (Los Alamos National Lab., NM (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Several full-scale pressurization experiments were performed on LANL rigid plug materials to determine resistance to gas pressures. In particular, a new candidate grout, HPNS-5, has been proposed to replace certain applications of two-part epoxy (TPE) plugs. The testing procedure consisted of placing pressure transducers within coarse and fines layers between two rigid plugs. Air was then forced into the coarse layer and the resulting time-dependent pressures were monitored. During emplacement of the test plugs and layers of fine and coarse stemming materials, every effort was made to follow as closely as possible actual stemming procedures used full scale emplacements. The effect of ground shock and slap down were investigated by performing a similar series of experiments in the rack assembly hole for the JUNCTION event. To determine the strength characteristics of PHNS-5, a structural frame was used to load the wire harnesses after the permeability tests were completed. The experimental data from all these experiments are presented and their implications for underground nuclear testing are discussed.

6512 (CONF-9309103–Vol.2, pp. 275-295) **A summary of LLNL containment: Diagnostics data, 1985-1993.** Hudson, B.; Stubbs, T. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

For normally buried underground nuclear tests, the site and depth of burial are chosen so that no radioactive material is expected at the surface as a result of leakage through the surrounding overburden media. Concurrently, the emplacement hole is stemmed so that it is not expected to provide a leakage path to the surface. Beginning with the GOLDSTONE event (12/85), the LLNL has used a system of granular stemming layers and sanded gypsum concrete (SGC) plugs for stemming emplacement holes. The major objective of this report is to summarize the containment-related performance of these plugs. A typical stemming plan is shown. Two types of diagnostics are used to confirm that plugs have been emplaced and have performed as designed: conductivity and temperature for emplacement; pressure and radiation for performance. The conductivity and temperature probes are used to monitor plug location, thickness, and temperature histories. The latter provides information concerning the strength of the plug material. While probe data have, on occasion, shown deviations between the designed and the as-built stemming column, no deviation indicated a compromise which would degrade SGC plug performance. Consequently, these data are not discussed in this report. Pressure and radiation sensors are placed between the plugs to indicate impedance to gas flow; EXCOR (EXtended CORrtex, a continuous, time-domain reflectometer) and motion sensors are used to indicate plug structural integrity (as a stemming platform) during collapse. Containment experience since beginning the use of SGC plugs has been satisfactory, i.e., no radioactive material has been detected at the surface during the first 24 hours after a detonation. They therefore conclude that currently employed methods and materials used for stemming emplacement holes have been adequate. However, performance-related data suggest that significant improvements in stemming reliability might be achievable.

6513 (CONF-9309103–Vol.2, pp. 297-311) **More RAMS data for selected LANL events.** Trent, B.C. (Los Alamos National Lab., NM (United States)); Marusak, N.L. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The data presented at the Sixth Containment Symposium has been updated to provide additional records on measured pressure and radiation from downhole remote area monitoring station (RAMS) packages. The updates include, as before, complete stemming diagrams as well as the locations of all monitor stations. Data is provided for all tests conducted since the last symposium. The collection of this data will reside in an existing database management system which will enhance the flexibility for analysis and comparison of different RAMS package time-histories.

6514 (CONF-9309103–Vol.2, pp. 315-345) **In situ convergence measurements and initial analysis from mine-by experiments in U12P and U12N tunnels at the Nevada Test Site, Nye County, Nevada.** Harris-West, B.L.; Fogel, M.B. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Quantifying the tunnel convergence phenomenon (the relaxation or displacement that occurs around a newly mined drift) is important for understanding the character and stress field of the in situ medium. Both of these factors are instrumental in modeling containment and structure response, and in determining support requirements for construction. A new technique was used during continuous mining of drifts in two tunnel complexes in 1988-1990 to actively measure and record when and where tunnel convergence occurred in relation to the mined face. For the first experiment, an electromechanical gauge was installed at the collar of each of six holes drilled to varying depths perpendicular to the

existing (Bypass) drift to measure displacement as mining proceeded by in the parallel (Main) drift. Over a four-day period in 1988, a 33.2-meter (109-foot) section of the U12p.03 Main drift was mined from 7.6 meters (25 feet) on the portal side of the first gauge anchor, located at the bottom of the hole, to more than 7.6 meters (25 feet) on the far side of the last gauge anchor. Data were recorded every 1 to 5 minutes, depending on the proximity of the face to the plane of the anchors. Longer term data were recorded every 2 hours for an additional 34 days.

6515 (CONF-9309103–Vol.2, pp. 363-397) **Use of a simple constitutive model for volcanic rocks of the southwestern Nevada volcanic field for the determination of hugoniots in testing media of the Nevada Test Site.** Olinger, B. (Los Alamos National Lab., NM (United States)); Fritz, J.N.; Warren, R.G.; Chipera, S.J. Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-36. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The authors' analysis of the known chemical and physical characteristics of Tertiary volcanic rocks of the southwestern Nevada volcanic field (SWNVF) indicates that rock alteration is the most important geologic consideration for shock-wave propagation. Volcanic rock chemistry is unusually consistent within the SWNVF as rhyolite, so chemical variation among and within volcanic units does not appear to significantly affect shock wave character. The three common alterations (vitric, devitrified, and zeolitic) appear to have consistent mineral assemblages throughout the SWNVF, and therefore each alteration type shows consistent physical properties throughout the SWNVF. In addition to alternation, porosity and degree of water saturation are important factors for shock-wave propagation. Rock porosity is strongly related to its lithology (e.g., lava, welded tuff), and degree of saturation is generally related to proximity to the water table. They obtained large samples from well-characterized vitric, devitrified, and zeolitic zones of the Topopah Spring Tuff, a rhyolitic, phenocryst-poor unit of the SWNVF. They measured shock-wave compression in each of these samples using explosive-driven systems that compared shock velocities in the rock samples with velocities in aluminum standards. Measurements have been repeated, artificially varying degrees of saturation and porosity to include the in situ range observed of saturation and porosity observed in Tertiary volcanic rocks of NTS subsurface.

6516 (CONF-9309103–Vol.2, pp. 399-406) **A comparison of the moisture gauge and the neutron log in air-filled holes at NTS.** Hearst, J.R. (Lawrence Livermore National Lab., CA (United States)); Carlson, R.C. Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Two methods are commonly used to measure water content of geologic materials by neutron diffusion. One is used mostly in agricultural, mining and civil engineering areas and is called a moisture gauge. The other is used principally in petroleum and mineral exploration, and is called a neutron log. Both are used at NTS, the moisture gauge principally in tunnels, the neutron log in vertical drilled holes. There is little communication between the two industrial groups, and the measurement instruments have evolved with very different operational characteristics, and one important physics difference, the source to detector spacing. The moisture gauge has a very short, 0-6 cm, spacing, with little internal shielding, and count increases with water. In contrast, the neutron log has a long spacing, 30-50 cm, substantial internal shielding, and exhibits decreasing count with increasing water. Because of its short spacing the moisture gauge gives better bed resolution than the neutron log. Because its count increases with water, the moisture gauge is more strongly affected by water in the borehole, especially in dry formations. In these conditions the neutron log is the method of choice. In air-filled holes, if source size or logging time is not a constraint, the relative sensitivity of the two tools to water is determined by the relative strengths of borehole effects as fluid, holesize, or tool-wall gap. If source size is a constraint for safety reasons, the short spacing provides higher countrates for a given detector efficiency and thus better relative precision in determining the true count. If source size is limited because of detector or electronics saturation, the short spacing will be better at high water content, while the long spacing will be better at low water content. In any case the short spacing may have an advantage because it can make better contact with the hole wall and it can be more easily corrected for gap.

6517 (CONF-9309103–Vol.2, pp. 407-412) **Maximum likihood borehole corrections for dual-detector density logs.** Carlson, R.C. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Dual-detector density logs have been used in the petroleum industry for years. The tool was designed with a second detector to allow compensation for the effect of a layer of mudcake between the tool and the formation being measured. The compensation algorithm commonly used calculates the correction to apply to the density measured by the long-spaced detector as proportional to the difference in the densities measured by the two detectors. The coefficient of proportionality is determined from experimental data taken with the tool in a fluid-filled hole of 15 to 40 cm diameter, with uniform thickness sheets of various materials simulating the mudcake. In applying this technology for the Containment program at the Department of Energy Nevada Test Site (NTS) the authors have discovered two problems. First, they frequently log in air-filled holes much larger than 40 cm. Correlations between the corrected data and the amount of correction applied suggest that the standard algorithm undercorrects in these circumstances. Second, the gap, or layer, is rarely uniform with depth or vertical position on the face of the tool. They have found that when the source end of the tool makes better contact with the wall than the detector end, the standard algorithms will undercorrect the data. When the reverse is true, the algorithm can overcorrect the data. They have developed a method to determine the proper amount of correction dynamically. No experimental data on the gap effect are needed as long as the two detectors are calibrated to read the proper density when the gap is zero. The method assumes that the form of the equation used in the standard algorithm is correct, but uses the variation of the two density signals with depth to determine the appropriate value of the coefficient, assuming true density varies more slowly than the gap effects.

6518 (CONF-9309103–Vol.2, pp. 413-418) **An in-situ check of the epithermal neutron log calibration.** Burkhard, N.R. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. DOE Contract W-7405-ENG-48. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The epithermal neutron log is used to measure the water content of the formation. The large hole epithermal neutron sonde (ENS) utilized at the Nevada Test Site (NTS) has been calibrated in the Hydrogen Content Test Facility (HCTF). These calibrations are used to correct the measured neutron count rate for the effects of tool stand-off and density. For some time, the suspicion has existed that the water contents that are calculated from the ENS data are too large. Hole U2gj represented a unique opportunity to check the validity of the ENS calibration under realistic logging conditions; a portion of the hole had been cemented and redrilled and then logged. The cements have a known water content and can be used as an in-situ calibration check. The author found that the water contents from the log data after processing with the existing

calibrations are consistent with these known cement water contents. In addition, the study indicates that the raw neutron data might be more appropriately smoothed by using a median smoother rather than the currently utilized mean smoother.

6519 (CONF-9309103–Vol.2, pp. 429) **Soil mounds at the Nevada Test Site: Natural or nuclear?.** Garcia, M.N. (Geological Survey, Denver, CO (United States)); Covington, H.R. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Pahute Mesa occupies the northwest portion of the Nevada Test Site (NTS) and ranges in elevation from about 1760 to 2230 m. It is composed of welded ash-flow tuffs and rhyolite lavas. Soil mounds have been observed in the field and on aerial photographs of the mesa that were taken prior- and subsequent-to subsurface nuclear testing. The mounds are commonly composed of loose, unstratified sediment and are surrounded by gravel at their bases. They range from 3 to 6 m in diameter, are generally less than 1 m in height, and are hemispherical. The mounds are most abundant on flat mesa surfaces, and they have not been observed on slopes greater than 15 degrees or in areas where the soil is sufficiently thick to support trees. Preliminary photogrammetric maps of the mesa show that the mounds form on mesa ridges where thin surficial material overlies thin welded ash-flow tuffs. No mounds have been observed on thick welded ash-flow tuffs or on rhyolite lavas. The origin of the mounds may be due in part to three natural causes: the burrowing of small animals along natural and nuclear-induced fractures, vegetation serving as traps for eolian sediment, and frost action. A fourth factor may be seismicity. A seismic explanation has been suggested for the origin of similar mounds in Washington State. The seismic explanation suggests that the mounds in Washington State formed where ground shaking affected unconsolidated fine sediments on a relatively rigid planar substratum. It is unclear whether the mound formation on Pahute Mesa coincided with either natural or nuclear-induced seismicity. Soil mounds have been observed on some aerial photographs that predate subsurface nuclear testing. Currently, studies are in progress to determine if mound shape and distribution have changed as a result of subsurface nuclear testing.

6520 (CONF-9309103–Vol.2, pp. 431) **Water-level map of eastern Pahute mesa and vicinity, Nevada Test Site, Nye County Nevada.** O'Hagen, M.D. (IT Corp., Las Vegas, NV (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

A water-level contour map of Eastern Pahute mesa and vicinity, Nevada Test Site, Nye County, Nevada was constructed using water levels measured in seventy-three drill holes. The water level map supports previous conceptualizations of ground-water movement beneath eastern Pahute Mesa. The drill holes were emplaced in volcanic rocks of the Silent Canyon Caldera complex, the Timber Mountain caldera and adjacent areas. Depth-to-water measurements range from 852 to 2,336 feet below land surface. Water-level altitudes range from 4,904 feet in the eastern part to 4,190 feet in the southeastern part of the map area. Within the Silent Canyon Caldera complex a northeast to southwest groundwater flow direction is indicated by the water-level contours. A north-south lateral ground-water flow barrier is located coincident with the western boundary of the Silent Canyon caldera complex. The barrier is defined on the basis of a steep hydraulic gradient resulting in higher water levels measured in drill holes located west of the caldera complex. West of the barrier, a north-south groundwater flow direction is indicated by the water-level contours. Anomalously high water levels in the eastern, central and southwestern map area are identified. The anomalous water levels may represent perched or semiperched conditions. Alternatively, the anomalous water levels may indicate transient perturbations of the ground-water system caused by underground nuclear testing.

6521 (CONF-9309103–Vol.2, pp. 433) **Groundwater levels from well and test-hole data, Yucca Flat, Nevada Test Site, Nye County, Nevada, 1959-91.** Hale, G.S. (Geological Survey, Las Vegas, NV (United States)); Trudeau, D.A. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

Groundwater levels at the Nevada Test Site, 65 miles northwest of Las Vegas, Nevada, have been affected by underground nuclear testing. Water-level data collected from wells and test holes during April 1959 through December 1991 in the Yucca Flat area are being evaluated by the U.S. Geological Survey, in cooperation with U.S. Department of Energy for their nuclear-test and environmental-assessment planning. These water-level data are being used to construct a water-table-altitude map by evaluating the location of wells and test holes, water-level measurements, the location of the contact between Paleozoic and Cenozoic rocks at the water table, and the generalized hydrostratigraphic (Paleozoic or Cenozoic) unit contributing water at each well or test hole. This information updates the map by Doty and Thordarson (1983), Water table in rocks of Cenozoic and Palezoic Age, 1980, Yucca Flat, Nevada, U.S. Geological Survey Water-Resources Investigations Report 83-4067. Within the Cenozoic rock of central Yucca Flat, the number of delineated groundwater mounds and the areal extent of mounding have increased since 1980. Generally, groundwater altitudes are higher in the Cenezoic rock of central Yucca Flat than in the underlying and adjacent Paleozoic carbonate rock. A more precise interpretation of groundwater flow in Yucca Flat is limited by sparse 1991 data, composite water-level data (the well or test hole is open to more than one hydrostratigraphic unit within saturated Paleozoic and Cenozoic rock), and the effects of nuclear testing on water levels. These limitations prevent an accurate interpretation of groundwater flow direction within Yucca Flat.

6522 (CONF-9309103–Vol.2, pp. 435) **An electromagnetic hole separation survey tool.** Goldwire, H.C. Jr. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

The authors describe an electromagnetic survey tool developed by others, which can be used to accurately determine the offset distances between various points in nearby emplacement holes or adits (e.g., the satellite hole offset from an emplacement hole at the device horizon in a vertical geometry emplacement). The technique was demonstrated on a vertical event at the Nevada Test Site. The basic theory of operation, sample data, and analyzed results are presented and compared to results obtained by conventional survey means.

6523 (CONF-9309103–Vol.2, pp. 437-445) **Destruction of chemical weapons by underground nuclear explosions.** Morel, B.; Black, S. Lawrence Livermore National Lab., CA (United States). [1993]. From 7. symposium on containment of underground nuclear explosions; Kent, WA (United States); 13-17 Sep 1993. In *Proceedings of the seventh symposium on containment of underground nuclear explosions. Volume 2.* 431p. Order Number DE95001250. Source: OSTI; NTIS; INIS; GPO Dep.

After several decades, the negotiation of a ban on production, possession and use of chemical weapons was completed in Geneva this summer. An important provision of the treaty is that the parties have ten years to destroy the chemical warfare agents and chemical weapons deployed on their territories. In contrast to the frenzy of other post-cold war demilitarization efforts, chemical weapons destruction presents significant unresolved technical and economic problems to a large number of states. Specific solutions may not be universally accepted because of technical, economic,

and societal differences. In particular, the use of underground nuclear detonations was dismissed in the West but is being examined by Russian scientists. The destruction of chemical weapons is more difficult and more expensive than their manufacture. In addition to their extreme toxicity, the high explosive bursting charge contained in many of the munitions adds a significant degree of difficulty. There have been many suggestions for industrial scale destruction of chemical weapons. The cost, difficulty and efficiency of these approaches vary, but none seem ideal. This article examines the feasibility of destroying chemical weapons with underground nuclear explosions.

4503 Nuclear Explosion Detection

Refer also to citation(s) 6172, 6173, 6495

6524 (LA-UR–94-3939) **The Department of Energy's Comprehensive Test Bank Treaty Research and Development Program.** Simons, D. (Los Alamos National Lab., NM (United States)); Stump, B.; Breding, D.; Casey, L.; Walker, L.; Zucca, J.; Harris, D.; Hannon, J.; Denny, M.; Patton, H. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950151–2: NATO (ASI)/monitoring a comprehensive test ban treaty, Algrave (Portugal), 23 Jan - 2 feb 1995). Order Number DE95003660. Source: OSTI; NTIS; INIS; GPO Dep.

The U.S. DOE sponsored research investigating atmospheric infrasound as a means of detecting both atmospheric and underground nuclear tests. Various detection schemes were examined and were found to be effective for different situations. It has been discovered that an enhanced sensitivity is realizable for the very lowest frequency disturbances by detecting the infrasound at the top of the atmosphere using radio sound techniques. These techniques are compared to more traditional measurement schemes.

6525 (LA-UR–94-3940) **Atmospheric methods for nuclear test monitoring.** Simons, D.J. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950151–3: NATO (ASI)/monitoring a comprehensive test ban treaty, Algrave (Portugal), 23 Jan - 2 feb 1995). Order Number DE95003659. Source: OSTI; NTIS; INIS; GPO Dep.

The U.S. DOE sponsored research investigating atmospheric infrasound as a means of detecting both atmospheric and underground nuclear tests. Various detection schemes were examined and were found to be effective for different situations. It has been discovered that an enhanced sensitivity is realizable for the very lowest frequency disturbances by detecting the infrasound at the top of the atmosphere using ratio sound techniques. These techniques are compared to more traditional measurement schemes.

4505 Strategic Defense Initiative

Refer also to citation(s) 5735

4506 Chemical and Biological

6526 (LA-UR–94-3736) **Effects of carbon blending and granule size layering on butane breakthrough curves.** Wood, G.O. (Los Alamos National Lab., NM (United States)); Karwacki, C. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9411158–1: 1994 U.S. Army Edgewood Research conference on development and Engineering (ERDEC), Edgewood, MD (United States), 15-18 Nov 1994). Order Number DE95003726. Source: OSTI; NTIS; GPO Dep.

Butane breakthroughs of packed granulated carbon beds were studied to provide information for the design of longer lasting gas mask canisters. Breakthrough curve data for 1,000 ppm butane were obtained and analyzed for adsorption capacities, rates and asymmetry parameters. Two commercial carbons with granules in the 12–30 mesh size range were used: (1) a chromium-free, impregnated carbon, ASZM-T, and (2) and unimpregnated activated carbon, BPL. These carbons were blended and layered in a 3:1 ratio, respectively, by volume to determined effects on adsorption capacities and rates. Six replicate layered beds (with the BPL layer downstream) and seven replicate blended beds of the carbons showed no statistical differences in rates or capacities. The ASZM-T carbon was separated into fractions in the 12–16, 16–20, and 20–30 mesh size ranges and used to prepare layered beds for testing. Keeping the total bed volume the same, backup layers of the smaller sized carbons increased adsorption rates up to 50%. However, because of the dominance of the capacity in determining breakthrough time, corresponding 1% butane breakthrough times increased only up to 6%.

54 ENVIRONMENTAL SCIENCES

Refer also to citation(s) 6002, 6267, 7037

5401 Environmental Sciences, Atmospheric

Refer also to citation(s) 4907, 4991, 5138, 5363, 5370, 5408, 5497, 5689, 5690, 5750, 5824, 5828, 5962, 6000, 6067, 6092, 6110, 6124, 6126, 6148, 6150, 6151, 6156, 6272, 6302, 6525, 6564, 6568, 6604, 6626, 6628, 7054

6527 (CONF-9406275–1) **Evaluation of the performance of an annular diffusion denuder.** Fan, B.J.; Cheng, Y.S.; Yeh, Hsu-Chi. Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM (United States). Inhalation Toxicology Research Inst. [1994]. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76EV01013. From Conferencce on obscuration and aerosol research; Aberdeen, MD (United States); 2-5 Jun 1994. Order Number DE95002258. Source: OSTI; NTIS; GPO Dep.

In air sampling, an annular diffusion denuder (ADD) is often used to trap specific gases from an air sample stream. The efficiency of an ADD in collecting a gas was considered in this study. A dimensional analysis showed that the collection efficiency depended on two parameters: the Peclet number and the annulus radii ratio. To determine collection efficiency, we calculated the fractional loss of the gas inside the denuder. In the calculation, the governing equations for gas concentration and flow field inside the annulus were solved numerically. After validating the methodology, a parameteric calculation of the collection efficiency was made, and a one-equation model based on the calculation was developed. A comparison of the model and experimental data showed a variance coefficient of 3.26%. This confirmed that the performance of an annular denuder could be evaluated by this model.

6528 (DOE/ER/61100–1) **Vertical array receptions of the Heard Island transmissions.** Baggeroer, A.B. (Massachusetts Inst. of Tech., Cambridge, MA (United States)); Lashkari, K.; Chiu, Ching-sang; Miller, J.H.; Mikhalevsky, P.; von der Heydt, K. Woods Hole Oceanographic Institution, MA (United States). 23 Mar 1993. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-91ER61100. Order Number DE94013784. Source: OSTI; NTIS; GPO Dep.

The Heard Island Feasibility Test (HIFT) demonstrated that coded acoustic signals could be detected at ranges up to 18,000 km with currently available source technology. This paper describes one component of the HIFT where a large aperture vertical line array was deployed to record the signals transmitted from Heard Island. We have performed four analysis Of the VLA receptions, of the Heard Island signals. All four suggest the presence of higher order modes. The frequency- vertical wavenumber analysis and the modal beamforming indicate that mode 3 has the highest amplitude while the modal fitting suggests that made 5–6 are largest. It is difficult to resolve the differences since the SNR at the VLA, nearly 18,000 km with a transmission loss of around 145 dB, is quite low. Individual arrivals could not be distinguished because of the long integration time necessitated by the low SNR.

6529 (DOE/ER/61206–3) **Atmospheric peroxides. Technical progress report.** Weinstein-Lloyd, J. State Univ. of New York, Old Westbury, NY (United States). Aug 1994. 12p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract FG02-91ER61206. Order Number DE95004435. Source: OSTI; NTIS; INIS; GPO Dep.

The research conducted in this program has furthered the development of a method for real-time analysis of hydrogen peroxide, methyl hydroperoxide, and hydroxymethyl hydroperoxide, the most abundant peroxides in the atmosphere. The Fenton method was used in a number of major field studies and the results used to test models of atmospheric photochemistry and observed diurnal profiles have shed light on the mechanism of formation of H2O2 and organic peroxides. The technique has also been adapted for analysis of peroxides in precipitation in an undergraduate analytical chemistry/instrumental analysis course.

6530 (DOE/ER/61728–T1) **Laboratory studies of the sensitivity of tropospheric ozone to the chemistry of sea salt aerosol. Final report, September 15, 1993–September 14, 1994.** Finlayson-Pitts, B.J. California State Univ., Fullerton, CA (United States). 15 Nov 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-93ER61728. Order Number DE95003607. Source: OSTI; NTIS; GPO Dep.

Ozone plays a critical role in both the chemistry and radiation balance of the troposphere. Understanding the factors controlling tropospheric ozone levels is critical to our understanding of a variety of issues in global chemistry and climate change. Chlorine atoms have the potential to contribute significantly to the ozone balance in the free troposphere. They can react directly with ozone or alternately, with organics and may actually lead to the formation of ozone in the presence of sufficient NO. Reactions of alkali halides in sea salt particles are a potential source of atomic chlorine, hence reactions of these alkali halides, especially those producing precursors to atomic chlorine, are of great interest. Finally, the mechanisms, intermediates and products of the Cl-biogenic reactions are unknown; these could serve as unique markers of chlorine atom chemistry in the troposphere, and hence are important to define.

6531 (ETDE/DE-mf–95726722) **Air pollution monitoring system in Lower Saxony. Data record on air quality in Lower Saxony 1978-1992.** Niedersaechsisches Landesamt fuer Oekologie, Hannover (Germany). Abt. Immissionsschutz. [1993]. 109p. (In German). Order Number DE95726722. Source: OSTI; NTIS (US Sales Only).

The purpose of this report is to present the detailed results of the monthly and annual reports compiled in the course of the fifteen years under review in such a way as to make visible the development and current situation of air pollution in Lower Saxony. This is achieved by depicting quantities characterising the main pollutants and making time series analyses and spatial differentiations. Air pollution with sulphur dioxide and dust has markedly decreased over the past five years. The implemented emission abatement measures were enhanced by favourable meteorological conditions, keeping these pollutant concentrations within the guide and limit values of the relevant WHO and EC directives. On the other hand, air pollutants emitted by motor vehicles such as nitrogen dioxide, benzene, and the secondary product ozone are attaining increasing significance. Concentrations of these pollutants have not yet decreased much. These developments should be taken into account in determining national, European and intercontinental standards of air pollution control. (orig.)

6532 (ETDE/DE-mf–95726974) **Highly volatile chlorinated hydrocarbons in Lower Saxony. Pt. 1. Production and application. Short version.** Technischer Ueberwachungs-Verein Hannover e.V. (Germany). Sep 1989. 55p. (In German). Sponsored by Umweltministerium des Landes Niedersachsen, Hannover (Germany). Order Number DE95726974. Source: OSTI; NTIS (US Sales Only).

According to the survey 90% of the losses of CFC's are incurred by emissions, about 5% are contained in poisonous wastes which are treated separately, 1-2% get into the waste water. 60-80% of the CFC's which contaminate waste water are stripped again usually in purification plants and emitted into the atmosphere as gas. The annual consumption of CFC's is therefore an indicator of the amounts of chlorinated hydrocarbons emitted annually by the users. The close coincidence of consumption and emission does, however, not apply to plants which give used chlorinated hydrocarbons to external companies for processing (e.g. metal processing plants, contents of encapsulated degreasing plants). (orig./EF)

6533 (INIS-mf–15070) **Anthropogenic climate change: Knowledge - decision - action.** Hoppenau, S. (Max-Planck-Institut fuer Meteorologie, Hamburg (Germany)). Behoerde fuer Schule, Jugend und Berufsbildung, Hamburg (Germany). Nov 1993. 32p. (In German). Order Number DE95726738. Source: OSTI; NTIS (US Sales Only); INIS.

The paper points out areas where climate research has established facts relevant to the issue of man's influence on climate. It also discusses which details in the current picture may yet be modified. In order to arrive at a valuation one must know how reliable are the research results obtained until now. If the global emission of greenhouse gases continues, climate change will be inevitable. If emissions continue over the long term, be it even at a constant level, then the climate will change at a rate and to an extent for surpassing all natural climate fluctuations. A management of civilisation that is based at all levels on continued and increasing greenhouse gas emission, therefore, causes lasting damage to the natural basis of our lives, the ecosystem of the Earth. The uncertainties that still remain from the climatological aspect even though they may be profound in some details, do not relieve politicians of their responsibility to act immediately. This, however, presupposes a consensus on ethical criteria of assessment. (orig.)

6534 (INIS-mf–15073) **Sensitivity study of land biosphere CO_2 exchange through an atmospheric tracer transport model using satellite-derived vegetation index data.** Report - Max-Planck-Institut fuer Meteorologie, v. 127. Knorr, W.; Heimann, M. Max-Planck-Institut fuer Meteorologie, Hamburg (Germany). Feb 1994. 26p. Order Number DE95726897. Source: OSTI; NTIS (US Sales Only); INIS.

We develop a simple, globally uniform model of CO_2 exchange between the atmosphere and the terrestrial biosphere by coupling the model with a three-dimensional atmospheric tracer transport model using observed winds, and checking results against observed concentrations of CO_2 at various monitoring sites. CO_2 fluxes are derived from observed greenness using satellite-derived Global Vegetation Index data, combined with observations of temperature, radiation, and precipitation. We explore a range of CO_2 flux formulations together with some modifications of the modelled atmospheric transport. We find that while some formulations can be excluded, it cannot be decided whether or not to make CO_2 uptake and release dependent on water stress. It appears that the seasonality of net CO_2 fluxes in the tropics, which would be expected to be driven by water availability, is small and is therefore not visible in the seasonal cycle of atmospheric CO_2. The latter is dominated largely by northern temperate and boreal vegetation, where seasonality is mostly temperature determined. We find some evidence that there is still considerable CO_2 release from soils during northern-hemisphere winter. An exponential air temperature dependence of soil release with a Q_{10} of 1.5 is found to be most appropriate, with no cutoff at low freezing temperatures. This result is independent of the year from which observed winds were taken. This is remarkable insofar as year-to-year changes in modelled CO_2 concentrations caused by changes in the wind data clearly outweigh those caused by year-to-year variability in the climate and vegetation index data. (orig.)

6535 (INIS-mf–15074) **Some sensitivities of a coupled ocean-atmosphere GCM.** Report - Max-Planck-Institut fuer Meteorologie, v. 128. Stockdale, T. (European Centre for Medium Range Weather Forecasts (ECMWF), Reading (United Kingdom)); Latif, M.; Burgers, G.; Wolff, J.O. Max-Planck-Institut fuer Meteorologie, Hamburg (Germany). Feb 1994. 30p. Order Number DE95726896. Source: OSTI; NTIS (US Sales Only); INIS.

A coupled ocean-atmosphere GCM is being developed for use in seasonal forecasting. As part of the development work, a number of experiments have been made to explore some of the sensitivities of the coupled model system. The overall heat balance of the tropics is found to be very sensitive to convective cloud cover. Adjusting the cloud parameterization to produce stable behaviour of the coupled model also leads to better agreement between model radiative fluxes and satellite data. A further sensitivity is seen to

changes in low-level marine stratus, which is under-represented in the initial model experiments. An increase in this cloud in the coupled model produces a small improvement in both the global mean state and the phase of the east Pacific annual cycle. The computational expense of investigating such small changes is emphasized. An indication of model sensitivity to surface albedo is also presented. The sensitivity of the coupled GCM to initial conditions is investigated. The model is very sensitive, with tiny perturbations able to determine El Nino or non-El Nino conditions just six months later. This large sensitivity may be related to the relatively weak amplitude of the model ENSO cycle. (orig.)

6536 (INIS-mf–15075) **Interdecadal variability in a global coupled model.** Report - Max-Planck-Institut fuer Meteorologie, v. 125. Storch, J.S. von. Max-Planck-Institut fuer Meteorologie, Hamburg (Germany). Jan 1994. 25p. Order Number DE95726899. Source: OSTI; NTIS (US Sales Only); INIS.

Interdecadal variations are studied in a 325-year simulation performed by a coupled atmosphere - ocean general circulation model. The patterns obtained in this study may be considered as characteristic patterns for interdecadal variations. 1. The atmosphere: Interdecadal variations have no preferred time scales, but reveal well-organized spatial structures. They appear as two modes, one is related with variations of the tropical easterlies and the other with the Southern Hemisphere westerlies. Both have red spectra. The amplitude of the associated wind anomalies is largest in the upper troposphere. The associated temperature anomalies are in thermal-wind balance with the zonal winds and are out-of-phase between the troposphere and the lower stratosphere. 2. The Pacific Ocean: The dominant mode in the Pacific appears to be wind-driven in the midlatitudes and is related to air-sea interaction processes during one stage of the oscillation in the tropics. Anomalies of this mode propagate westward in the tropics and the northward (southwestward) in the North (South) Pacific on a time scale of about 10 to 20 years. (orig.)

6537 (IVL-B–1154) **Levels of SO_2, soot (black smoke), NO_2 and VOC in ambient air in Swedish urban areas, together with SO_2 and NO_2 at neighbouring rural sites, winter 1993-1994.** Svanberg, P.A. (Swedish Environmental Research Inst., Gothenburg (Sweden)); Bostroem, C.E.; Backstroem, H. Swedish Environmental Research Inst., Goeteborg (Sweden). 1994. 123p. (In Swedish). Order Number DE95723988. Source: OSTI; NTIS.

The report presents the results from the 8th consecutive measurement campaign within the URBAN project. During the campaign, October 1993-March 1994, measurements were carried out in 32 different urban areas. The measurements are based mostly on 24 hour average concentrations of sulphur dioxide, soot and nitrogen dioxide in each of the urban centres. In addition, for 24 of the participating boroughs, monthly measurements of SO_2 and NO_2 at two sites in rural areas neighbouring the urban areas were undertaken. For the second consecutive year the project included measurements of volatile organic compounds at 22 of the urban areas. The subsequent analyses included the determination of 8 components; benzene, toluene, m- + p-xylene, o-xylene, ethyl benzene, butyl acetate, octane and nonane. The results have been compiled together with the corresponding meteorological data. In addition, the results from background air measurements at the Swedish sites within the EMEP network are presented. Besides the conventional presentation of results with comparison with the national air quality standards, linear correlation tests between the measured parameters, meteorological data and even other general data supplied by the boroughs concerning population, traffic work etc. are reported. The regional and long distance transport background contributions for air quality in the urban areas, as well as the variations within the urban areas have been discussed on the basis of the obtained results. In this year's evaluation, the Swedish Environmental Protection Agency's decision concerning the introduction of ambient air standards has been considered. In addition, the report also describes the results achieved concerning: The method development concerning the testing of a 'NO_x' diffusion sampler; Reproducibility tests on diffusion samplers for VOC; and Active 24 hour sampling of VOC. 21 refs, numerous figs and tabs

6538 (KFK–5242) **Ground based measurements of relevant trace gases for studying the ozone chemistry in the Arctic stratosphere using Fourier transform spectrometers.** Thomas, P.; Clarmann, T. v.; Blumenstock, T.; Fischer, H.; Gerhardt, L.; Gulde, T.; Oelhaf, H.; Scheuerpflug, W.; Stiller, G.P.; Trieschmann, O.; Wegner, A. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Meteorologie und Klimaforschung. Mar 1994. 32p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 01VOZ15. Order Number DE95733152. Source: OSTI; NTIS (US Sales Only).

This is the final report of a project, which was funded by the German Federal Ministry for Research and Technology (BMFT), file No. 01 V0Z15 6, and was conducted from 1 March, 1990 until 30 June, 1993. It was the goal of the project to record zenith column amounts (ZCA's) of trace gases, which are relevant to ozone chemistry and to the development of ozone sinks in the Arctic. Above all, the contribution of dynamic and chemical processes was to be clarified as well as the question whether parallels can be drawn between the chemistry of the Arctic and the Antarctic stratosphere. The equipment used were two Fourier transform spectrometers (FTS). They allow the IR spectrum of direct sunlight to be measured which is attenuated selectively by the atmospheric trace gases, dependent on their concentrations. To be able to calculate the ZCA's, synthetic spectra are fitted to the measured ones taking into account the measuring geometry, and by varying vertical profiles of the mixing ratios used to calculate the synthetic spectra. An advantage offered by this measuring technique is that the ZCA's of many trace gases can be determined simultaneously in the same probed mass of air. (orig.)

6539 (NEI-DK–1740) **Measurement of aerosols.** Simonsen, O. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Inst. for Kemiteknik. Sep 1989. 8p. (In Danish). Contract ENS-1223/90-0033. Order Number DE95723839. Source: OSTI; NTIS.

EFP-90.

A brief description of some methods for measuring sulphuric acid clouds. The methods could be used in relation to laboratory experiments to demonstrate a mathematical model for the formation of aerosols. (AB)

6540 (NEI-DK–1741) **Aerosol kinetics. A description of formation, growth and coagulation of mist droplets.** Simonsen, O. Danmarks Tekniske Hoejskole, Lyngby (Denmark). Inst. for Kemiteknik. Mar 1990. 22p. (In Danish). Contract ENS-1223/90-0033. Order Number DE95723840. Source: OSTI; NTIS.

EFP-90.

A short summary of work on mathematical models for the description of the formation, growth and coagulation of mist droplets in aerosols. (AB) (18 refs.)

6541 (NEI-NO–442) **Monitoring artificial radioactivity in the Nordic countries. BER-2 final report.** Bennerstedt, T.; Rantanen, H.; Mortensen, B.N. No corporate text available. May 1994. 5p. (CONF-9405256–: Nordic seminar on emergency preparedness in nuclear accidents, Oslo (Norway), 4-6 May 1994). Order Number DE95609818. Source: OSTI; NTIS (US Sales Only); INIS.

This final report of the Nordic Nuclear Safety Research Project BER-2 gives detailed information on the monitoring of artificial radioactivity in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). A comparison shows that for early warning the Nordic countries use a mix of stations measuring external gamma radiation and stations measuring airborne radioactivity. There is a trade-off between fast alarms and the sensitivity threshold. Total gamma measuring stations cannot detect increases smaller than the variations of normal background. Some stations, notably all Danish stations, are equipped with sodium iodide (NaI) type detectors, and operated in such a way that stray peaks due to an increase in the natural radon background can be subtracted. A Nordic Radiation Data Exchange System has been set up and tested on a trial basis. This system focuses on dose rate data from the automatic gamma monitoring stations. An important goal achieved in the project was to determine which data is essential, and to specify a common format for the data exchange. Various telecommunication methods have been tested, and the actual transfer of monitoring results between the Nordic countries was started. It is recommended as a future approach that every country

appoint one organization with the responsibility of operating a national information data base, which can be commonly accessed from all the Nordic countries. A procedure for establishing a system of this type has been outlined.

6542 (ORNL/CDIAC–65) **Trends '93: A compendium of data on global change.** Boden, T.A.; Kaiser, D.P.; Sepanski, R.J.; Stoss, F.W.; Logsdon, G.M. (eds.). Oak Ridge National Lab., TN (United States). Sep 1994. 1031p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. (ESD–4195). Order Number DE95004456. Source: OSTI; NTIS; GPO Dep.

This document provides synopses of frequently used global-change data. This third issue of the Trends series presents historical and modern records of atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), two chlorofluorocarbons (CFC-11 and CFC-12), a hydrochlorofluorocarbon (HCFC-22), and two halons (H-1301 and H-1211) from an expanded number of globally distributed data sets. Virtually all of the modern records extend into the 1990s, some into 1994. Additional trace gas data presented in Trends '93 include historical atmospheric CO_2, CH_4, and N_2O records derived from ice cores. Trends '93 also includes revised and updated estimates through 1991 for global, regional, and national CO_2 emissions produced from the burning of fossil fuels, gas flaring, and the production of cement. Updated global emissions estimates through 1992 are also presented for CFC-11 and CFC-12. In addition, Trends '93 updates and expands the presentation of long-term temperature records, whose spatial coverage ranges from an individual Antarctic (ice core) site to the entire globe and from the Earth's surface to the lower stratosphere. New subject matter appearing in Trends '93 includes a chapter for long-term regional precipitation records, several time-series records for atmospheric - ^{14}C aerosols, and isotopic measurements for atmospheric CO_2 from several sites. Data records are presented in multipage formats, each dealing with a specific site, region, or emissions species. The data records include tables; graphs; discussions of methods for collecting, measuring, and reporting the data; trends in the data, and references to literature providing further information. Instructions for citing specific data in Trends '93 are provided for each compiled data set. All data appearing in Trends '93 are available on digital media from the Carbon Dioxide Information Analysis Center (CDIAC).

6543 (SAND–94-8699C) **Tunable diode lasers as continuous emission monitors for thermal waste treatment processes.** Allendorf, S.W. (Sandia National Labs., Livermore, CA (United States)); Ottesen, D.K.; Johnsen, H.A.; Wang, J.; Frish, M.D.; Trembley, D.G.; Severance, R.; Boni, A.A. Sandia National Labs., Livermore, CA (United States). [1994]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DR00789. (CONF-940528–7: Incineration conference: 13th international symposium on thermal treatment technologies, Houston, TX (United States), 9-13 May 1994). Order Number DE95004381. Source: OSTI; NTIS; GPO Dep.

In this paper the ongoing program to develop and apply a family of on-line process monitors is described. This technique detects molecular gas-phase species by optical absorption using vibrational transitions in the near-infrared region. Near-infrared, tunable diode lasers are used that emit extremely narrow, single-mode radiation. Current efforts include laboratory work to identify the optimum absorption lines for the molecular species of interest. Sensors based on tunable diode lasers are being developed in parallel with this scoping work. One such instrument, designed to monitor ammonia, has been constructed and field-tested; its specification and performance are discussed.

6544 (SVF–514) **Evaluation of SNCR-systems in steam- and hot water boilers in Sweden.** Gromulski, J. (Vattenfall Utveckling AB, Vaellingby (Sweden)); Hinderson, A.; Johansson, Annika; Sfiris, G.; Sjoeberg, M.; Westermark, M. Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Oct 1994. 153p. (In Swedish). Order Number DE95723969. Source: OSTI; NTIS.

Figures and tables with text in English.

SNCR (Selective Non-Catalytic Reduction) is a method for removing nitrogen oxides that has attracted a lot of attention and has been installed at several plants, both in Sweden and abroad. The chemical basis for the method is the reaction of nitrogen compounds having a large hydrogen content (e.g. ammonia, urea) with nitrogen oxides, resulting in the formation of nitrogen. The maximum removal is obtained when the reducing chemical is injected at a point where the fuel gas temperature is 870-1010 degrees C. This report is a summary of the results of a comprehensive study supported financially by NUTEK (Swedish National Board for Industrial and Technical Development), Svensk Energi Utveckling AB (Swedish Energy Development Corporation), Vattenfall AB (the largest Swedish power supplier), Vaermeforsk (Thermal Engineering Research Inst.) and the participating plants. The project has involved seven Swedish plants, where the environmental, operational and economic characteristics of the SNRC process have been evaluated. The reported operating experience from the plants indicate that the method is fairly simple and does not require a great deal of surveillance and service. In most cases there is no need to add personnel and no great changes in the maintenance routines have to be made. The SNCR systems have not caused production problems at any of the plants studied. The most commonly reported problem seems to be nozzle congestion, which requires some surveillance and cleansing. Nozzle congestion can also cause varying injection performance, which may in turn lead to less removal, higher ammonia emissions and increased risk of furnace corrosion. 23 refs, 115 figs, 8 tabs

6545 (SVF–518) **Evaluation and comparison of different techniques for monitoring ammonia in flue gas.** Johansson, Annika (Vattenfall Utveckling AB, Vaellingby (Sweden)); Harnevie, H.; Axelsson, H. Stiftelsen foer Vaermeteknisk Forskning, Stockholm (Sweden). Oct 1994. 111p. (In Swedish). Project Vaermeforsk-B1-317. Order Number DE95723970. Source: OSTI; NTIS.

Figures and tables with text in English.

Since the introduction of $deNO_x$ processes based on injection of ammonia or urea, the determination of ammonia in flue gases has been associated with a lot of uncertainty. Measurement results achieved with different techniques have often given poor agreement with each other, which has led to difficulties for performance evaluations of SCR/SNCR installations. The aim of this project has been to clarify some of the reasons for the observed discrepancies between different measurement techniques. The work has been limited to measurement techniques for gaseous ammonia in clean gas. A general conclusion from testing of continuous measurement systems is that both IR and UV systems can be considered well suited for ammonia analyses in most flue gas applications. However, discrepancies between different measuring systems were found, but these are more likely to be due to the individual instrument design than to a certain measuring principle. Factors such as function of the instrument's specific evaluation routines, calibration routines, the construction of the sampling system etc proved to be of great importance for the instrument's performance. The analyses results from the wet chemical measurements were often in good agreement with the results from the continuous measurement systems, although some tests that gave very different results. From this data, some recommendations for wet chemical analyses have been proposed. One conclusion from the intercalibration is that all of the examined analysis methods (i.e. the indophenol method, ion chromatography and the salicylate method) are well suited for ammonium analyses, provided that the analyses are carried out properly. 20 refs, 39 figs, 27 tabs

6546 (UCRL-JC–118477) **Remote sensor test range update.** Slaughter, D. Lawrence Livermore National Lab., CA (United States). Jul 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9404162–15: 1994 chemical analysis by laser interrogation of proliferation effluents (CALIOPE ITR) interim technical review, Livermore, CA (United States), 26-28 Apr 1994). Order Number DE95003629. Source: OSTI; NTIS; GPO Dep.

It has been recognized since the beginning of the CALIOPE remote sensor development program that performance criteria must be developed to measure progress and efficacy, then prototype sensors must be evaluated against them. Much of the early evaluation may be carried out cost effectively in the laboratory and at field ranges located near each of the participating national laboratories. However, sensor performance is expected to be degraded

by many factors in the field at remote sites and the extent of that degradation must be quantified before instruments can be designed and constructed for international deployment. LLNL proposed a series of field tests for this purpose at the Remote Sensor Test Range (RSTR) located at the Nevada Test Site (NTS). Well-controlled gas plumes containing mixtures of important species at known concentration would be released to the open atmosphere and used as targets for the prototype remote sensors. The plume dimensions and gas concentrations will be well diagnosed to provide "ground truth". Gases selected as targets will, in the beginning, be chosen to optimize instrument performance in the field and identifying those factors that limit performance. The initial experiments will use ground based-instruments observing the target plumes from relatively close range. Field tests will evolve toward gases identified by the "signatures study" (McDowell, Aldis, Elder-Session II these proceedings) as relevant to proliferant activity. Target concentrations will be reduced to those expected in proliferant scenarios and may be modulated in time. Observation range will be increased, and elevated or airborne sensor platforms will be introduced.

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Refer also to citation(s) 4955, 5024, 5135, 5138, 5139, 5156, 5157, 5177, 5180, 5208, 5210, 5217, 5218, 5219, 5266, 5284, 5301, 5349, 5359, 5360, 5370, 5381, 5382, 5383, 5385, 5404, 5408, 5409, 5411, 5414, 5415, 5417, 5430, 5431, 5432, 5434, 5437, 5438, 5442, 5470, 5540, 5552, 5750, 5824, 6007, 6074, 6273, 6466, 6534, 6578, 6618, 7016, 7054, 7072, 7082

6547 (DOE/EM–0224) **Summary report of a workshop on phytoremediation research needs.** USDOE Assistant Secretary for Environmental Restoration and Waste Management, Washington, DC (United States). Dec 1994. 24p. Sponsored by USDOE, Washington, DC (United States). (CONF-9407155–Summ.: Workshop on phytoremediation research needs, Santa Rosa, CA (United States), 24-26 Jul 1994). Order Number DE95006076. Source: OSTI; NTIS; INIS; GPO Dep.

Soil contamination is a national and global problem. A major challenge is the remediation of large sites contaminated with radionuclides and toxic metals, often present in relatively small amounts but above regulatory action levels. Despite the function of phytoremediation processes in nature for millenia, the technology of phytoremediation is, for the most part, still a concept. There are many different pollutants, plant uptake mechanisms, soil matrices, and plant species that need to be investigated, without overlooking the microbial participation in this technology. Developing actual practical applications will require a significant and coordinated research and development effort, due to the complexity of both biological systems and the soil contamination problems. Research and development in this area must involve scientists and engineers in Federal and state agencies, foreign organizations and industry. The representation at the workshop of researchers from many disciplines, organizations and countries, augurs well for a cooperative and interdisciplinary research effort and the rapid application of this technology. The urgent needs for effective, low-cost technologies to clean-up contaminated soils, both in the US and around the world, suggests phytoremediation as a high national and international research priority. The availability of scientists trained in the interdisciplinary topics relating to phytoremediation will be a major factor in expediting development of this technology.

6548 (DOE/MC/29467–3939) **Decontamination Systems Information and Research Program: Quarterly report, July–September 1994.** National Research Center for Coal and Energy, Morgantown, WV (United States). Nov 1994. 377p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FC21-92MC29467. Order Number DE95000033. Source: OSTI; NTIS; INIS; GPO Dep.

West Virginia University (WVU) and the US DOE Morgantown Energy Technology Center (METC) entered into a Cooperative Agreement on August 29, 1992 entitled "Decontamination Systems Information and Research Programs" (DOE Instrument No.: DE-FC21-92MC29467). Stipulated within the Agreement is the requirement that WVU submit to METC a series of Technical Progress Reports on a quarterly basis. This report comprises the eighth Quarterly Technical Progress Report for the Agreement. This report reflects the progress and/or efforts performed on the 16 technical projects encompassed by the Agreement for the period of July 1 through September 30, 1994. These projects focus on the following: Bio-remediation of organic compounds, heavy metals, and radionuclides; miscellaneous remediation technologies; instrumentation; and technology assessments.

6549 (DOE/SR/18271–T1) **Degradation of mix hydrocarbons by immobilized cells of mix culture using a trickle fluidized bed reactor. Final report: June 1992–June 1994.** Chapatwala, K.D. Selma Univ., AL (United States). Div. of Natural Sciences. [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-92SR18271. Order Number DE95003819. Source: OSTI; NTIS; GPO Dep.

The microorganisms capable of degrading mix hydrocarbons were isolated from the soil samples collected from the hydrocarbon contaminated sites. The mix cultures were identified as Pseudomonas acidovorans, Flavobacterium indoltheticum and Phyllobacterium rubiaceum. The bacterial cells of mix cultures were immobilized in calcium-alginate solution in the form of beads. A trickle fluidized bed air-uplift-type reactor designed to study the degradation of mix hydrocarbons was filled with 0.85% normal saline containing the immobilized cells of mix culture. The immobilized beads were aerated with different amounts of CO_2-free air. The normal saline saturated with BTXs was circulated in the bioreactors at the rate of 2–4 ml/min. The biodegradation of BTXs by the immobilized beads of mix culture was monitored by determining the concentrations of the BTXs and the metabolites formed during their degradation in the samples at regular intervals using GC. The peaks obtained through the degradation of BTXs were not identified and quantified in this study.

6550 (EGG–11265-2035) **The effect of drought on four plant communities in the northern Mojave Desert.** Schultz, B.W. (Desert Research Inst., Reno, NV (United States)); Ostler, W.K. EG and G Energy Measurements, Inc., Las Vegas, NV (United States). [1993]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-93NV11265. (CONF-9310276–12: 8. wildland shrub and arid land restoration symposium, Las Vegas, NV (United States), 19-21 Oct 1993). Order Number DE95004166. Source: OSTI; NTIS; GPO Dep.

Desert plant communities contain many perennial plant species that are well adapted to arid environments; therefore, one would intuitively believe that perennial desert species readily survive drought conditions. Abundant research on plant-soil-water relationships in North American deserts has shown that many species can maintain water uptake and growth when the soil-water potential is low. Little research, however, has focused on how prolonged drought conditions affect plant species in vegetation associations in desert ecosystems. A prolonged and widespread drought occurred in much of the western United States, including the Northern Mojave Desert, from 1987 through 1991. During this drought period vegetation characterization studies, initiated in 1990, by the US Department of Energy (DOE) at Yucca Mountain, Nevada, allowed EG and G Energy Measurements to collect data that could be used to infer how both desert vegetation associations and desert plant species reacted to a prolonged drought. This paper presents the preliminary results.

6551 (GKSS–94/E/6) **Mapping of pollutants in sediments of the German Wadden Sea - June, 1989 to June, 1992. Final report January 1993.** Koopmann, C. (GKSS-Forschungszentrum Geesthacht GmbH (Germany). Inst. fuer Physik); Faller, J.; Bernem, K.H. van; Prange, A.; Mueller, A. GKSS-Forschungszentrum Geesthacht GmbH (Germnay). Jan 1994. 160p. (In German). Sponsored by Umweltbundesamt, Berlin (Germany). Contract UFOPLAN 10903377. (UBA-FB–93-109). Order Number DE95726118. Source: OSTI; NTIS (US Sales Only); INIS.

From June 1989 to June 1992 a mapping of inorganic and organic pollutants in the sediments from the entire German Wadden Sea has been carried out. Following the guidelines of the national (Bund/Laender-Messprogramm) and international monitoring programmes for the North Sea (Joint Monitoring Programme) distribution patterns of pollutants according to their type and concentration have been determined in the course of this investigation

and the main pollution areas have been established. Based on the results of the mapping of pollutants, as well as on the first findings of the biological mapping, a concept for the monitoring of pollutants in eulittoral sediments of the German Wadden Sea has been developed. (orig.)

6552 (GRI–94/0037) **Pipeline corridors through wetlands - impacts on plant communities: Bayou Grand Cane, De Soto Parish, Louisiana. Topical report, August 1991–July 1993.** Shem, L.M. (Argonne National Lab., IL (United States)); Zimmerman, R.E.; Hayes, D.; Van Dyke, G.D. Argonne National Lab., IL (United States). Dec 1994. 54p. Sponsored by Gas Research Inst., Chicago, IL (United States). DOE Contract W-31109-ENG-38. Source: OSTI; Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631.

The goal of the Gas Research Institute Wetland Corridors Program is to document impacts of existing pipeline on the wetlands they traverse. To accomplish this goal, 12 existing wetland crossings were surveyed. These sites varied in elapsed time since pipeline construction, wetland type, pipeline installation techniques, and night of-way (ROW) management practices. This report presents the results of a survey conducted over the period of August 12-13, 1991, at the Bayou Grand Cane crossing in De Soto Parish, Louisiana, where a pipeline constructed three years prior to the survey crosses the bayou through mature bottomland hardwoods. The sit was not seeded or fertilized after construction activities. At the time of sampling, a dense herb stratum (composed of mostly native species) covered the 20-m-wide ROW, except within drainage channels. As a result of the creation of the ROW, new habitat was created, plant diversity increased, and forest habitat became fragmented. The ROW must be maintained at an early stage of succession to allow access to the pipeline however, impacts to the wetland were minimized by decreasing the width of the ROW to 20 m and recreating the drainage channels across the ROW. The canopy trees on the ROW's edge shaded part of the ROW, which helped to minimize the effects of the ROW.

6553 (GRI–94/0226) **Pipeline corridors through wetlands - impacts on plant communities: Bayou Pointe Aux Chenes, Terrebonne Parish, Louisiana. Topical report, August 1991–April 1994.** Van Dyke, G.D.; Shem, L.M.; Zimmerman, R.E. Argonne National Lab., IL (United States). Dec 1994. 40p. Sponsored by Gas Research Inst., Chicago, IL (United States). DOE Contract W-31109-ENG-38. Order Number DE95004390. Source: OSTI; Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631; NTIS; GPO Dep.

The goal of the Gas Research Institute Wetland Corridors Program is to document impacts of existing pipelines on the wetlands they traverse. To accomplish this goal, 12 existing wetland crossings were surveyed. These sites varied in elapsed time since pipeline construction, wetland type, pipeline installation techniques, and night- of-way management practices. This report presents the results of a survey conducted on August 22, 1991, in an emergent intertidal estuarine wetland in Terrebonne Parish, Louisiana. The site includes three pipelines installed between 1958 and 1969. Vegetation within the site comprises three native tidal marsh grasses: Spartina alterniflora, Spartina patens, and Distichlis spicata. All three species occurred over the pipelines, within the right-of-way and in both natural areas. Vegetative differences attributable to the installation or presence of the pipelines were not obvious over the pipelines or in the habitat east of the pipelines. However, because of the presence of a canal west of the 1969 pipeline, vegetation was less abundant in that area, and D. spicata was absent from all but the most distant plots of the transacts. Data obtained in the study indicate that when rights-of-way through brackish marsh are restored to their original elevations, they are revegetated with native vegetation similar to that in surrounding areas.

6554 (INIS-JP–024, pp. B450/1-B450/11) **Measuring techniques for environmental natural radiation. Neutron and Radon α-rays.** Sato, Hiroo (Aloka Co. Ltd., Mitaka, Tokyo (Japan)). Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (In Japanese). (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

This review covers a neutron pocket dosimeter and monitor for the detection of radiation quantities above the environmental radiation level, and a compact readout Radon monitor. (author).

6555 (JAERI-Research–94-010) **Environmental simulation test for radionuclide migration under wet-dry cycle condition in aerated zone.** Tanaka, Tadao (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Yamamoto, Tadatoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 38p. (In Japanese). Order Number DE95737225. Source: OSTI; NTIS; INIS.

Influence of discontinuous water flow based on repeated cycle of rainfall and evaporation (wet-dry cycle condition) on the migration behavior of ^{60}Co, ^{85}Sr and ^{137}Cs in a sandy soil layer has been demonstratively investigated by using the equipment of environmental simulation test for radionuclide migration, in order to establish a reliable evaluation method of the radionuclide migration in natural barrier, in relation to the safety assessment on shallow land disposal of low-level radioactive waste. Migration velocity of cationic ^{85}Sr, concentrations of particulate ^{60}Co and ^{137}Cs in the deeper soil layer, pH and ion concentration dissolved in the soil layer under the wet-dry cycle condition became larger than those under the continuous flow condition. Increase of the migration velocity of cationic ^{85}Sr under the wet-dry cycle condition was attributed to that the concentration of Ca^{2+}, by which the sorption ability of ^{85}Sr onto soils was reduced, increased in interstitial water during an interruption period of water flow. On the other hand, the migration velocity of cationic ^{60}Co and ^{137}Cs was not affected by the wet-dry cycle condition. Increase of the concentration of particulate ^{60}Co and ^{137}Cs under the wet-dry cycle condition was probably caused from that movable $\{^{60}Co(OH)_2\}_n$ and ^{137}Cs fixed on fine soil particles were produced during the interruption period. (author).

6556 (JAERI-Research–94-014) **Radionuclide transfer onto ground surface in surface water flow. 2. Undisturbed tuff rock.** Mukai, Masayuki (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment); Takebe, Shinichi; Komiya, Tomokazu. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1994. 32p. (In Japanese). Order Number DE95737267. Source: OSTI; NTIS; INIS.

Radionuclide migration with ground surface water flow is considered to be one of path ways in the scenario for environmental migration of the radionuclide leaked from LLRW depository. To study the radionuclide migration demonstratively, a ground surface radionuclide migration test was carried out by simulating radioactive solution flowing on the sloped tuff rock surface. Tuff rock sample of 240 cm in length taken from the Shimokita district was used to test the transfer of ^{60}Co, ^{85}Sr and ^{137}Cs onto the sample surface from the flowing radioactive solution under restricted infiltration condition at flow rates of 25, 80, 160ml/min and duration of 56h. The concentration change of the radionuclides in effluent was nearly constant as a function of elapsed time during the experimental period, but decreased with lower flow rates. Among the three radionuclides, ^{137}Cs was greatly decreased its concentration to 30% of the inflow. Adsorbed distribution of the radionuclides concentration on the ground surface decreased gradually with the distance from the inlet, and showed greater gradient at lower flow rate. Analyzing the result by the migration model, where a vertical advection distribution and two-dimensional diffusion in surface water are adopted with a first order adsorption reaction, value of migration parameters was obtained relating to the radionuclide adsorption and the surface water flow, and the measured distribution could be well simulated by adopting the value to the model. By comparing the values with the case of loamy soil layer, all values of the migration parameters showed not so great difference between two samples for ^{60}Co and ^{85}Sr. For ^{137}Cs, reflecting a few larger value of adsorption to the tuff rock, larger ability to reduce the concentration of flowing radioactive solution could be indicated than that to the loamy soil surface by estimation for long flowed distance. (author).

6557 (LA-SUB–94-167) **Modeling erosion and transport of depleted uranium, Yuma Proving Ground, Arizona.** Ward, T.J.; Stevens, K.A. New Mexico State Univ., Las Cruces, NM (United States). New Mexico Water Resources Research Inst. Jun 1994. 86p. Sponsored by Department of Defense, Washington, DC (United States);Department of the Interior, Washington, DC (United States). DOE Contract W-7405-ENG-36. (WRRI–286). Order Number DE95003451. Source: OSTI; NTIS; GPO Dep.

The high density, relative abundance, and metallic properties have made depleted uranium (DU) an obvious choice for high energy ballistic projectiles. The U.S. Army's Yuma Proving Ground (YPG) in southwest Arizona tests DU projectiles. When DU projectiles strike a target or the downrange ground surface, they fragment. Most of the fragments are collected after the test firings, but some are either too small or too dispersed to be easily found. Unfortunately, DU has some undesirable characteristics, it is a radioactive material (alpha particle emitter) and a toxic metal. Therefore, the fragments not found pose a potential environmental hazard at the YPG and to surrounding areas. The U.S. Army has contracted with the Los Alamos National Laboratory (LANL) to study the fate of DU at the YPG. In turn, LANL has contracted with New Mexico State University (NMSU) to investigate water transport of DU during rainfall-runoff events. Nine simulation runs were made on YPG soil containing DU fragments from the impact areas. The nine simulations consisted of three groups of three: rainfall simulation only, overland flow only, and rainfall/overland flow combination. Infiltration rates in the DU ballistic impact areas at YPG were very close to zero. Larger concentrations of DU were contained in the impact area soil which was retained by the 1 mm and 0.5 mm sieves when grain-size analysis was performed. After all nine simulations were completed, a mass balance of the uranium showed most DU remained in the soil box even under extreme hydraulic conditions, though about 7% (by weight) did exit the box. No DU was found in the suspended sediment samples and this suggests that most transport of DU is restricted to contact or bedload movement during overland flow. Because the experiments were conducted to simulate extreme rainfall-runoff conditions, the probability of significant transport of DU from land surface appears to be low.

6558 (LA-UR–94-3833) **Frijolito Watershed: Integrated investigations of a rapidly eroding pinyon-juniper hillslope.** Wilcox, B.P. (Los Alamos National Lab., NM (United States)); Pitlick, J.; Allen, C.D. Los Alamos National Lab., NM (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9411157–1: Semiarid hydrology conference, Tucson, AZ (United States), 1-3 Nov 1994). Order Number DE95003689. Source: OSTI; NTIS; INIS; GPO Dep.

The dramatic acceleration of erosion associated with the expansion of pinyon-juniper woodlands over the past 100 years has been widely recognized, but few process-based studies of this phenomenon have been undertaken. In an attempt to identify the underlying causes, and the factors that affect erosion processes, we have initiated an interdisciplinary study of a rapidly eroding pinyon-juniper woodland in northern New Mexico. Since July 1993, we have collected data on runoff, erosion, and weather conditions from a 1-ha catchment study area and have conducted surveys of topography, soils, and vegetation. Our preliminary results indicate that although runoff makes up less than 10% of the annual water budget, runoff events - which are frequent in the summer - are capable of moving large amounts of sediment. We estimate that between July 1993 and October 1994, between 25,000 and 50,000 kg of sediment has eroded and been transported from the catchment. The information gained from such studies is essential to our ability to formulate effective strategies for managing these rapidly eroding woodlands.

6559 (LBL–36086) **A TOUGH2 equation-of-state module for the simulation of two-phase flow of air, water, and a miscible gelling liquid.** Finsterle, S. (Lawrence Berkeley Lab., CA (United States). Earth Sciences Div.); Moridis, G.J.; Pruess, K. Lawrence Berkeley Lab., CA (United States). May 1994. 40p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95004816. Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.

The injection of grout into the subsurface can be used to encapsulate contaminated regions of an aquifer, or to form underground barriers for the isolation of contaminant sources and to prevent the spreading of existing plumes. This requires identifying grouts, or barrier fluids, which when injected into the subsurface exhibit a large increase in viscosity and eventually solidify, sealing the permeable zones in the aquifer. Simulation and modeling analysis are indispensable tools for designing the injection and predicting the performance of the barrier. In order to model flow and transport in such systems, the thermophysical properties of the fluid mixtures have to be provided, and the governing mass- and energy-balance equations for multiphase flow in porous media have to be solved numerically. The equation-of-state module EOS11 described herein is an extension of the EOS7 module of the TOUGH2 code for flow of saline water and air. In the modeling approach, the chemical grout is treated as a miscible fluid the viscosity of which is a function of time and concentration of the gelling agent in the pore water. If a certain high viscosity is reached and the movement of the grout plume ceases, the gel is assumed to solidify, leading to a new porous medium with changed soil characteristics, i.e. reduced porosity and permeability, increased capillary strength for a given water content, and changed initial saturation distribution.

6560 (LBL–36088) **Optimizing multiphase aquifer remediation using ITOUGH2.** Finsterle, S. (Lawrence Berkeley Lab., CA (United States). Earth Sciences Div.); Pruess, K. Lawrence Berkeley Lab., CA (United States). Jun 1994. 29p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95004817. Source: OSTI; NTIS; GPO Dep.

The T2VOC computer model for simulating the transport of organic chemical contaminants in non-isothermal multiphase systems has been coupled to the ITOUGH2 code which solves parameter optimization problems. This allows one to use nonlinear programming and simulated annealing techniques to solve groundwater management problems, i.e. the optimization of multiphase aquifer remediation. This report contains three illustrative examples to demonstrate the optimization of remediation operations by means of simulation-minimization techniques. The code iteratively determines an optimal remediation strategy (e.g. pumping schedule) which minimizes, for instance, pumping and energy costs, the time for cleanup, and residual contamination. While minimizing the objective function is straightforward, the relative weighting of different performance measures–e.g. pumping costs versus cleanup time versus residual contaminant content–is subject to a management decision process. The intended audience of this report is someone who is familiar with numerical modeling of multiphase flow of contaminants, and who might actually use T2VOC in conjunction with ITOUGH2 to optimize the design of aquifer remediation operations.

6561 (NEI-SE–161) **Radioactive cesium in boreal forest ecosystems.** Palo, T. (Swedish Univ. of Agricultural Sciences, Umeaa (Sweden). Dept. of Forest Zooecology); Bergman, R.; Nylen, T. Swedish Univ. of Agricultural Sciences, Umeaa (Sweden). Dept. of Animal Ecology. [1994]. 13p. (In Swedish). Project SSI-P756.93; SSI-P757.93. Order Number DE95610897. Source: OSTI; NTIS; INIS.

The report describes the migration, transfer and radioecological concentration of radioactive cesium in boreal forests. 17 refs, 6 figs.

6562 (ORNL/ER–68) **Groundwater quality monitoring well installation for Lower Waste Area Grouping 2 at Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental Restoration Program.** Mortimore, J.A.; Lee, T.A. Oak Ridge National Lab., TN (United States). Sep 1994. 263p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95002289. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the drilling and installation of 11 groundwater quality monitoring (GQM) wells on the perimeter of Lower Waste Area Grouping (WAG) 2. Lower WAG 2 consists of White Oak Lake and the embayment below White Oak Dam above the

Clinch River. The wells in Lower WAG 2 were drilled and developed between December 1989 and September 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements. The wells at Lower WAG 2 were drilled with auger or air rotary rigs. Depending on the hydrogeologic conditions present at each proposed well location, one of three basic installation methods was utilized. Detailed procedures for well construction were specified by the Engineering Division to ensure that the wells would provide water samples representative of the aquifer. To ensure conformance with the specifications, Energy Systems Construction Engineering and ERCE provided continuous oversight of field activities. The purpose of the well installation program was to install GQM wells for groundwater characterization at Lower WAG 2. Data packages produced during installation activities by the ERCE hydrogeologists are an important product of the program. These packages document the well drilling, installation, and development activities and provide valuable data for well sampling and WAG characterization. The forms contained in the packages include predrilling and postdrilling checklists, drilling and construction logs, development and hydraulic conductivity records, and quality control-related documents.

6563 (ORNL/ER–73) **Groundwater quality monitoring well installation for Waste Area Grouping at Oak Ridge National Laboratory, Oak Ridge, Tennessee. Environmental Restoration Program.** Mortimore, J.A.; Lee, T.A. Oak Ridge National Lab., TN (United States). Sep 1994. 323p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95002288. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the drilling and installation of 18 groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 11. WAG 11 (White Wing Scrap Yard) is located on the west end of East Fork Ridge between White Wing Road and the Oak Ridge Turnpike. The scrap yard is approximately 25 acres in size. The wells at WAG 11 were drilled and developed between January 1990 and October 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements. The wells at WAG 11 were drilled with auger or air rotary rigs. Depending on the hydrogeologic conditions present at each proposed well location, one of four basic installation methods was utilized. Detailed procedures for well construction were specified by the Engineering Division to ensure that the wells would provide water samples representative of the aquifer. To ensure conformance with the specifications, Energy Systems Construction Engineering and ERCE provided continuous oversight of field activities. The purpose of the well installation program was to install GQM wells for groundwater characterization at WAG 11. Data packages produced during installation activities by the ERCE hydrogeologists are an important product of the program. These packages document the well drilling, installation, and development activities and provide valuable data for well sampling and WAG characterization. The forms contained in the packages include predrilling and postdrilling checklists, drilling and construction logs, development and hydraulic conductivity records, and quality control-related documents.

6564 (PNL–10180) **Environmental settings for selected U.S. Department of Energy installations - support information for the Programmatic Environmental Impact Statement.** Holdren, G.R.; Glantz, C.S.; Berg, L.K.; Delinger, K.; Goodwin, S.M.; Rustad, J.R.; Schalla, R.; Schramke, J.A. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 380p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95005255. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains the environmental setting information developed for 20 U.S. Department of Energy (DOE) installations in support of the DOE's Programmatic Environmental Impact Study (PEIS). The objective of the PEIS is to provide the public with information about the types of radiological and hazardous wastes and environmental contamination problems associated with major DOE facilities across the country, and to assess the relative risks that these wastes pose to the public, onsite workers, and the environment. Environmental setting information consists of the site-specific data required to model (using the Multimedia Environmental Pollutant Assessment System) the atmospheric, groundwater, and surface water transport of contaminants within and near the boundaries of the installations. The environmental settings data describes the climate, atmospheric dispersion, hydrogeology, and surface water characteristics of the installations. The number of discrete environmental settings established for each installation was governed by two competing requirements: (1) the risks posed by contaminants released from numerous waste sites were to be modeled as accurately as possible, and (2) the modeling required for numerous release sites and a large number of contaminants had to be completed within the limits imposed by the PEIS schedule. The final product is the result of attempts to balance these competing concerns in a way that minimizes the number of settings per installation in order to meet the project schedule while at the same time providing adequate, if sometimes highly simplified, representations of the different areas within an installation. Environmental settings were developed in conjunction with installation experts in the fields of meteorology, geology, hydrology, and geochemistry. When possible, local experts participated in the initial development, fine tuning, and final review of the PEIS environmental settings.

6565 (PSI–94-12) **INTRAVAL Finnsjoen Test - modelling results for some tracer experiments.** Jakob, A. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Hadermann, J. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Sep 1994. 82p. Order Number DE95610898. Source: OSTI; NTIS; INIS.

This report presents the results within Phase II of the INTRAVAL study. Migration experiments performed at the Finnsjoen test site were investigated. The study was done to gain an improved understanding of not only the mechanisms of tracer transport, but also the accuracy and limitations of the model used. The model is based on the concept of a dual porosity medium, taking into account one dimensional advection, longitudinal dispersion, sorption onto the fracture surfaces, diffusion into connected pores of the matrix rock, and sorption onto matrix surfaces. The number of independent water carrying zones, represented either as planar fractures or tubelike veins, may be greater than one, and the sorption processes are described either by linear or non-linear Freundlich isotherms assuming instantaneous sorption equilibrium. The diffusion of the tracer out of the water-carrying zones into connected pore space of the adjacent rock is calculated perpendicular to the direction of the advective/dispersive flow. In the analysis, the fluid flow parameters are calibrated by the measured breakthrough curves for the conservative tracer (iodide). Subsequent fits to the experimental data for the two sorbing tracers strontium and cesium then involve element dependent parameters providing information on the sorption processes and on its representation in the model. The methodology of fixing all parameters except those for sorption with breakthrough curves for non-sorbing tracers generally worked well. The investigation clearly demonstrates the necessity of taking into account pump flow rate variations at both boundaries. If this is not done, reliable conclusions on transport mechanisms or geometrical factors can not be achieved. A two flow path model reproduces the measured data much better than a single flow path concept. (author) figs., tabs., 26 refs.

6566 (PSI–94-13) **Grimsel Test Site: modelling radionuclide migration field experiments.** Heer, W. (Paul Scherrer Inst. (PSI), Villigen (Switzerland)); Hadermann, J. Paul Scherrer Inst. (PSI), Villigen (Switzerland). Sep 1994. 137p. Order Number DE95610899. Source: OSTI; NTIS; INIS.

In the migration field experiments at Nagra's Grimsel Test Site, the processes of nuclide transport through a well defined fractured shear-zone in crystalline rock are being investigated. For these experiments, model calculations have been performed to obtain indications on validity and limitation of the model applied and the data deduced under field conditions. The model consists of a hydrological part, where the dipole flow fields of the experiments are determined, and a nuclide transport part, where the flow field driven nuclide propagation through the shear-zone is calculated. In addition to the description of the model, analytical expressions are given to guide the interpretation of experimental results. From the

analysis of experimental breakthrough curves for conservative uranine, weakly sorbing sodium and more stronger sorbing strontium tracers, the following main results can be derived: (i) The model is able to represent the breakthrough curves of the migration field experiments to a high degree of accuracy, (ii) The process of matrix diffusion is manifest through the tails of the breakthrough curves decreasing with time as $t^{-3/2}$ and through the special shape of the tail ends, both confirmed by the experiments, (iii) For nuclide sorbing rapidly, not too strongly, linearly, and exhibiting a reversible cation exchange process on fault gouge, the laboratory sorption coefficient can reasonably well be extrapolated to field conditions. Adequate care in selecting and preparing the rock samples is, of course, a necessary requirement. Using the parameters determined in the previous analysis, predictions are made for experiments in a smaller an faster flow field. For conservative uranine and weakly sorbing sodium, the agreement of predicted and measured breakthrough curves is good, for the more stronger sorbing strontium reasonable, confirming that the model describes the main nuclide transport processes adequately. (author) figs., tabs., 29 refs.

6567 (SAND–91-1526) **Benchmark testing and independent verification of the VS2DT computer code.** McCord, J.T. (Sandia National Labs., Albuquerque, NM (United States). Environmental Risk Assessment and Risk Management Dept.); Goodrich, M.T. Sandia National Labs., Albuquerque, NM (United States). Nov 1994. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004386. Source: OSTI; NTIS; INIS; GPO Dep.

The finite difference flow and transport simulator VS2DT was benchmark tested against several other codes which solve the same equations (Richards equation for flow and the Advection-Dispersion equation for transport). The benchmark problems investigated transient two-dimensional flow in a heterogeneous soil profile with a localized water source at the ground surface. The VS2DT code performed as well as or better than all other codes when considering mass balance characteristics and computational speed. It was also rated highly relative to the other codes with regard to ease-of-use. Following the benchmark study, the code was verified against two analytical solutions, one for two-dimensional flow and one for two-dimensional transport. These independent verifications show reasonable agreement with the analytical solutions, and complement the one-dimensional verification problems published in the code's original documentation.

6568 (SAND–94-1292) **1993 site environmental report Tonopah Test Range, Tonopah, Nevada.** Culp, T.; Howard, D.; McClellan, Y. Sandia National Labs., Albuquerque, NM (United States). Oct 1994. 180p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004270. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the environmental surveillance activities conducted by Sandia National Laboratories, the US Environmental Protection Agency, and Reynolds Electrical and Engineering Company for the Tonopah Test Range operated by Sandia National Laboratories. Sandia National Laboratories' responsibility for environmental monitoring results extend to those activities performed by Sandia National Laboratories or under its direction. Results from other environmental monitoring activities are included to provide a measure of completeness in reporting. Other environmental compliance programs such as the National Environmental Policy Act of 1969, environmental permits, and environmental restoration and waste management programs are also included in this report, prepared for the US Department of Energy in compliance with DOE Order 5400.1.

6569 (SAND–94-8732C) **Case study on the destruction of organic dyes in supercritical water.** LaJeunesse, C.A.; Rice, S.F. Sandia National Labs., Livermore, CA (United States). [1994]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. (CONF-950241–1: 5. international symposium on chemical oxidation, Nashville, TN (United States), 15-17 Feb 1995). Order Number DE95002482. Source: OSTI; NTIS; GPO Dep.

Organic dyes, which were used in Navy shells to mark ships and structures, need to be disposed of without burning. A study was undertaken to assess the feasibility of using supercritical water oxidation to destroy organic dyes. Experimental destruction efficiencies, product analyses, and process configuration are reported.

6570 (TVA/WM–93/10) **General design, construction, and operation guidelines: Constructed wetlands wastewater treatment systems for small users including individual residences. Second edition.** Steiner, G.R.; Watson, J.T. Tennessee Valley Authority, Chattanooga, TN (United States). May 1993. 42p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003303. Source: OSTI; NTIS.

One of the Tennessee Valley Authority's (TVA's) major goals is cleanup and protection of the waters of the Tennessee River system. Although great strides have been made, point source and nonpoint source pollution still affect the surface water and groundwater quality in the Tennessee Valley and nationally. Causes of this pollution are poorly operating wastewater treatment systems or the lack of them. Practical solutions are needed, and there is great interest and desire to abate water pollution with effective, simple, reliable and affordable wastewater treatment processes. In recognition of this need, TVA began demonstration of the constructed wetlands technology in 1986 as an alternative to conventional, mechanical processes, especially for small communities. Constructed wetlands can be downsized from municipal systems to small systems, such as for schools, camps and even individual homes.

6571 (UCRL-JC–117678) **Innovative technologies for in-situ remediation.** Ragaini, R.; Aines, R.; Knapp, R.; Matthews, S.; Yow, J. Lawrence Livermore National Lab., CA (United States). Jun 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9210194–12: International symposium on environmental contamination in Central and Eastern Europe, Budapest (Hungary), 12-16 Oct 1992). Order Number DE94017174. Source: OSTI; NTIS; INIS; GPO Dep.

LLNL is developing several innovative remediation technologies as long-term improvements to the current pump and treat approaches to cleaning up contaminated soils and groundwater. These technologies include dynamic underground stripping, in-situ microbial filters, and remediation using bremsstrahlung radiation. Concentrated underground organic contaminant plumes are one of the most prevalent groundwater contamination sources. The solvent or fuel can percolate deep into the earth, often into water-bearing regions. Collecting as a separate, liquid organic phase called dense non-aqueous-phase liquids (DNAPLs), or light NAPLs (LNAPLs), these contaminants provide a source term that continuously compromises surrounding groundwater. This type of spill is one of the most difficult environmental problems to remediate. Attempts to remove such material requires a huge amount of water which must be washed through the system to clean it, requiring decades. Traditional pump and treat approaches have not been successful. LLNL has developed several innovative technologies to clean up NAPL contamination. Detailed descriptions of these technologies are given.

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Refer also to citation(s) 5023, 5138, 5157, 5162, 5174, 5359, 5430, 5551, 5605, 5733, 5858, 6265, 6551, 6564, 6570

6572 (AECS-PR-G/FRSR–85) **Natural radioactivity in hot and mineral waters in Syria.** Othman, I. (Atomic Energy Commission, Damascus (Syrian Arab Republic). Dept. of Radiation Protection and Nuclear Safety); Abbass, M.; Kattan, Z. Atomic Energy Commission, Damascus (Syrian Arab Republic). Dept. of Radiation Protection and Nuclear Safety; Atomic Energy Commission, Damascus (Syrian Arab Republic). Dept. of Geology and Nuclear Ores. Aug 1994. 64p. (In Arabic). Order Number DE95610920. Source: OSTI; NTIS (US Sales Only); INIS.

A study of water chemistry and radioactivity of hot and mineral ground waters was conducted in Syria in order to determine the natural radioactivity levels as well as the mobility process of major radionuclides in the studied systems. The water samples were collected generally from carbonate and basaltic aquifer systems. The chemistry of groundwaters was a reflection of the rock type, while no relationship was found between the radionuclide activities and

water temperatures. The increase of ^{222} Rn concentration in hot and mineral waters was accompanied by a similar increase of the concentration of its patent radionuclides (U_{tot} and ^{226} Ra). In parallel, the relative increase of ^{222} Rn concentration was correlated significantly with the presence of the large faults systems prevailing in the studied areas (Palmyrides and Great African Faults Systems). In all the cases, the radionuclide activity levels were below the maximum contaminant levels given for drinking water and health effects. (author). 11 refs., 7 figs., 8 tabs.

6573 (CIEMAT–748) **Lake-0: A model for the simulation of nuclides transfer in lake scenarios.** Garcia-Olivares, A.; Aguero, A.; Pinedo, P. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 92p. Order Number DE95722442. Source: OSTI; NTIS; INIS.

This report presents documentation and a user's manual for the program LAKE-0, a mathematical model of nuclides transfer in lake scenarios. Mathematical equations and physical principles used to develop the code are presented in section 2. The program use is presented in section 3 including input data sets and output data. Section 4 presents two example problems, and some results. The complete program listing including comments is presented in Appendix A. Nuclides are assumed to enter the lake via atmospheric deposition and carried by the water runoff and the dragged sediments from the adjacent catchment. The dynamics of the nuclides inside the lake is based in the model proposed by Codell (11) as modified in (5). The removal of concentration from the lake water is due to outflow from the lake and to the transfer of activity to the bottom sediments. The model has been applied to the Esthwaite Water (54 degree 21 minute N, 03 degree 00 minute W at 65 m. asl.) in the frame of the VAMP Aquatic Working Group (8) and to Devoke Water (54 degree 21 minute 5'N, 03 degree, 18 minute W at 230 m. asl.)

6574 (CIEMAT–752) **DRENA: A model for the transport of nuclides in drainage slopes.** Garcia-Olivares, A.; Aguero, A.; Pinedo, P. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 92p. Order Number DE95730387. Source: OSTI; NTIS; INIS.

This report presents documentation and a user's manual for program DRENA, a mathematical model of nuclides transfer in simple slopes and sections of a drainage catchment. Mathematical equations and physical principles utilized to develop the code are presented in section 2. The flowchart and some mathematic and numerical details are presented in Section 3. Section 4 presents an overview of how problems should be set up to properly use the code as well as the detailed input instructions and output results formats. One example problem, including sample input data sets and output data, are presented in Section 5. The complete program listings including comments are presented in the Appendices. Nuclides are assumed to enter the catchment via atmospheric deposition and then carried by the water runoff and the dragged sediments. The desorption/adsorption dynamics between water and sediments are considered to be in the equilibrium given by a Kd parameter, a distribution coefficient. Codell's and Einstein expressions for the caudal and concentration of dragged sediments are utilized. (Author)

6575 (CRIE-U–93048) **Development of water purification technologies for intensive fish culture. 10. Rearing of Japanese flounder with closed seawater recirculation system equipped with immobilized bacteria.** Uemoto, H.; Watanabe, Y.; Kikuchi, K. Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Mar 1994. 22p. (In Japanese). Order Number DE95730181. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

Japanese flounder were reared by a seawater recirculation and filtration system with immobilized bacteria. As a water purification system, used were a nitrification tank and denitrification tank which were both filled with immobilized nitrifying bacteria and denitrifying bacteria, respectively. The flounder could be reared for 180 days with their body weight doubled at the end of experiment. Ammonia exhausted from the flounder was not accumulated in the rearing water. Nitric acid produced by the oxidation of ammonia was prevented from heightening its concentration in the denitrification tank. Usable immediately after having been filled into the filtration tank, both immobilized nitrifying and denitrifying bacteria are stable in activity without being affected by organic matter in the rearing water. The dissolution and disintegration of carrier were not confirmed. The high activity of immobilized nitrifying bacteria and denitrifying bacteria was observed on the surface and in the central part, respectively of the carrier. The activity of both bacteria was confirmed inside the carrier. From the foregoing, the high density rearing was known to be possible even in a filtration tank miniaturized to the size of about 20% of the conventional one. 29 refs., 18 figs., 2 tabs.

6576 (DOE/EH–0426) **Comprehensive baseline environmental audit of former underground test areas in Colorado, Nevada, and New Mexico.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). May 1994. 146p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003291. Source: OSTI; NTIS; INIS; GPO Dep.

This report documents the results of the Comprehensive Baseline Environmental Audit of Former Underground Test Areas (FUTAS) in the States of Colorado, Nevada, and New Mexico. DOE and contractor systems for management of environmental protection activities on the Nevada Test Site (NTS) were not within the scope of the audit. The audit was conducted May 16-May 26, 1994, by the Office of Environmental Audit (EH-24). DOE 5482.1 B, "Environment, Safety, and Health Appraisal Program", establishes the mission of EH-24, which is to provide comprehensive, independent oversight of Department-wide environmental programs on behalf of the Secretary of Energy. The ultimate goal of EH-24 is to enhance environmental protection and minimize risk to public health and the environment. EH-24 accomplishes its mission using systematic and periodic evaluations of DOE's environmental programs within line organizations and supplemental activities that strengthen self-assessment and oversight functions within program, field, and contractor organizations. These evaluations function as a vehicle through which the Secretary and program managers are apprised of the status and vulnerabilities of Departmental environmental activities and environmental management systems. Several types of evaluations are conducted, including: (1) comprehensive baseline environmental audits; (2) routine environmental audits; (3) environmental management assessments; and (4) special issue reviews.

6577 (INIS-JP–024, pp. B440/1-B440/10) **New measurement techniques of environmental radioactivity. Methods of surveying marine radioactivity.** Kobayashi, Yoshii (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Industrial Forum, Inc., Tokyo (Japan); Japan Radioisotope Association, Tokyo (Japan); Atomic Energy Society of Japan, Tokyo (Japan). 1994. 596p. (In Japanese). (CONF-940268–: 21. Japan conference on radiation and radioisotopes, Tokyo (Japan), 2-4 Feb 1994). In *Proceedings of the 21st Japan conference on radiation and radioisotopes. The 100th year since the discovery of X-ray, and expectation to the future development.* Order Number DE94785275. Source: OSTI; NTIS; INIS.

Measurements of radioactivity have been carried out in solution or suspension in sea-water, bottom sediments and specific marine organisms. The general approach to radionuclide measurement in seawater and bottom sediments has been concentration by coprecipitation, adsorption, ion exchange or solvent extraction. These methods employed are based primarily on shipboard collection of samples followed by land-based laboratory analyses and are too time-consuming. For rapid measurement, in situ measurement of seawater or seabed gamma-ray has developed. A gamma-ray detecting probe containing the NaI(Tl) scintillation or germanium detector is enclosed in a sealed cylinder. The measurements are made by suspending the probe in a 200-300 liter tank and passing seawater through the tank by means of ship deck pumping system, towing the probe across the seafloor, hanging down the probe to the seabed, or loading the probe on a remotely operated undersea vehicle. In situ measurement of gamma-ray in the marine environment has some application to a mineral exploration and to monitoring of sea areas which may become contaminated as the result of accidents or contamination incidents. This article reviews several gamma-ray detecting probes and describes the recent

studies at JAERI on the development of a small electric-cooled Ge gamma-ray detector and a marine environmental radioactivity investigation system for in situ measurement of gamma-ray. (J.P.N.).

6578 (INIS-mf–14298) **Baseline data compilation on radioactivity levels in drinking water, groundwater, waste water, sewage sludge, residues and wastes, accompanying the 1990 annual report on 'Environmental radioactivity and radiation burden'.** WaBoLu-Hefte, v. 5/1993. Abelmann, S.; Buenger, T.; Ruehle, H.; Viertel, H. Bundesgesundheitsamt, Berlin (Germany). Inst. fuer Wasser-, Boden- und Lufthygiene. 1993. 203p. (In German). Order Number DE95733336. Source: OSTI; NTIS (US Sales Only); INIS.

The report summarizes the data measured in 1990 in compliance with the Preventive Radiation Protection Act. The measured values of the environmental monitoring stations established in the vicinity of nuclear installations in compliance with the Directive for Emission Monitoring of Nuclear Installations are given in tables showing the data for groundwater, drinking water, and liquid effluents. (HP)

6579 (INIS-mf–15069) **Filtration and flocculating filtration.** Verfahrensberichte zur Abwasserbehandlung, v. 14. Verband der Chemischen Industrie e.V., Frankfurt am Main (Germany). Ausschuss Wasser und Abwasser. Dec 1992. 29p. Order Number DE95726951. Source: OSTI; NTIS (US Sales Only); INIS.

Filtration of the sewage effluents of secondary sedimentation tanks serves to reduce the concentration of filtrable materials and to remove substances contained or adsorbed therein, e.g., heavy metals, oxygen-depleting substances, nitrogen and phosphorus compounds, and AOX-relevant substances. On the other hand, filtration is not a compensation for insufficient secondary treatment. The filter capacity depends on the types of substances to be filtered. In continuous operation, the upper limit will be about 20-40 mg/l. Higher capacities are possible for short periods of time. For further reduction of phosphates filtration is supplemented by filtration and flocculation (flocculating filtration). (orig./EF)

6580 (TVA/WM–93/13) **Aerial inventory of land uses and nonpoint pollution sources in the Lick Creek Watershed of the Nolichuky River Basin.** Carroll, T.L. Tennessee Valley Authority, Chattanooga, TN (United States). May 1993. 388p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). Order Number DE95003304. Source: OSTI; NTIS.

Low altitude color infrared (CIR) aerial photography to survey and inventory land uses and potential nonpoint sources of pollution which included eroding streambanks, eroding roadbanks, and livestock sites. The survey area encompassed the watersheds of the Lick Creek drainage in the Nolichucky River Basin in Northeast Tennessee. Land use inventories assist stream quality evaluations by characterizing land use and nonpoint pollution sources (NPS) that have the potential to cause offsite stream impacts. Survey results for this study are based on land use conditions during March 1990. The Lick Creek drainage comprises about 164,856 acres. Pastureland is the predominant land use representing 59 percent of the total watershed area, followed by forestland (32 percent), cropland (6 percent), urban land with (2 percent), and disturbed land (<1 percent). Most of the estimated total soil loss for the watershed derives from pastureland (69 percent), followed by cropland (21 percent), disturbed land (7 percent), and forest land (3 percent). Disturbed land has the highest average field soil loss for the watershed, at 161.2 tons/acre/year. Cattle operations are the predominant type of livestock operation in the Lick Creek drainage. Most of these cattle operations are unconfined and not adjacent to streams. Eroding streambanks and roadbanks, in addition to producing sediment in the stream, provide a means for nonpoint source pollution to enter streams without being first filtered, as through a vegetative cover. In the Lick Creek drainage, there are 14.2 miles of eroding streambanks and 2.3 miles of channelized stream segments, out of a total stream length for the watershed of 1,091.7 miles. There are 4.6 miles of livestock access to streams 181.1 miles of probable livestock access to streams, and 169.6 miles of potential livestock access to streams. Finally, there are 56.1 miles of eroding roadbanks, and 311.1 miles of unpaved roads.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

Refer also to citation(s) 6641, 6642

6581 (IVL-B–1158) **Study of thermophilic anaerobic cleaning systems.** Boman, B.; Davisson, G. Swedish Environmental Research Inst., Stockholm (Sweden). Nov 1994. 18p. (In Swedish). Order Number DE95723962. Source: OSTI; NTIS.

The aim of this study was to indicate how mesophile and thermophilic anaerobic systems differ in their capacity to degrade persistent organic compounds. The experiments were carried out in semi-batch lab.scale reactors working at 35, 55 and 70 degrees C and were evaluated by recording pH, COD, TSS, redox potential, fatty acids, gas production, methane concentration and the concentration of specific organic compounds. Totally, seven different reactors and four different specific organic compounds were used in this study. The microbial activity within the semi-batch reactors showed a pronounced tendency to oscillate in an irregular and unpredictable way. This behaviour stressed the difficulties in running the decided experiments. These experiences are unfortunately confirmed by many other investigators within the present field. The results do not indicate differences between mesophile and thermophilic anaerobic reactors in terms of 'not degradable-degradable' but only as differences in degree of degradation rates. 6-chlorovanillin and 3,5-dinitrobenzoic acid showed increasing degradation rate in the thermophilic range while no differences could be detected for 4,5-dichloroguaiacol. In the case of β-sitosterol the mesophile reference reactor crash. 14 refs, 6 figs, 3 tabs

5501 Behavioral Biology

6582 (PNL–9987) **Ferruginous hawks on the Yakima Training Center.** Mazaika, R.; Cadwell, L.L. Pacific Northwest Lab., Richland, WA (United States). Jul 1994. 61p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE94017393. Source: OSTI; NTIS; GPO Dep.

Habitat quality for ferruginous hawks (Buteo regalis) is largely determined by availability of nest sites and adequate prey base. A limitation of one of these will limit the number of hawks in an area. In general, ferruginous hawks are adaptable to various nesting substrates and will nest in proximity to other closely related sympatric species (e.g., red-tailed hawk, Swainson's hawk). This analysis focused on an assessment of prey base availability and habitat disturbance in the vicinity of historic nest sites and small mammal trap sites on the Yakima Training Center (YTC) in Washington State. The primary ground-disturbing activities on the YTC are associated with military training, fire, and grazing. In addition to the direct effect these activities can have on ferruginous hawks, indirect effects may result from changes in composition, density, and structure of vegetation that subsequently alter faunal population numbers and species diversity. A summary of results of small mammal trapping, population estimation, vegetative analysis and disturbance rating at seven trap sites during the time period of June through August of 1993 are presented.

5502 Biochemistry

Refer also to citation(s) 6121, 6585, 6586, 6629, 6630

6583 (DOE/ER/20019–T1) **Genetic and biophysical studies of the photosynthetic reaction center: Final technical report.** Youvan, D.C. Massachusetts Inst. of Tech., Cambridge, MA (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-90ER20019. Order Number DE95004179. Source: OSTI; NTIS; GPO Dep.

This research is aimed at understanding how critical amino acid residues (and peptides) interact to modify the chemistry of the prosthetic groups, for example: (1) in determining whether bacteriochlorophyll (BC) or bacteriopheophytin (BP) is bound at particular sites, (2) in facilitating electron transfer between prosthetic groups either by direct mechanisms or superexchange, (3) in modifying redox or spectral properties of the prosthetic groups, (4) in imparting

resistance to certain quinone inhibitors, such as the triazine herbicides, and (5) in directing the path of the photoelectron down only one of two apparent pathways in the reaction center. A principal engineering goal of this research is to construct "wrong-way" electron transfer mutants. This will be accomplished either by changing the specificity of tetrapyrrole binding sites (BC <-> BP interconversion) or by "swapping" entire helices through the pseudo C2 symmetry axis. Such mutants are important for understanding pigment-protein assembly as well as mechanistic aspects of photochemistry. This report lists a point-by-point summary of the most important findings in the research over the past 4 years. More time and effort was dedicated to combinatorial mutagenesis on light harvesting antennae than initially proposed. The additional award from DOE for building a Digital Imaging Spectrophotometer (DIS) led to the development of general tools for studying the spectra of mutants directly on petri dishes. Applications of DIS should be even more general, including energy studies in plants and cyanobacteria.

6584 (ORNL/TM–12821) **Correcting sequencing errors in DNA coding regions using a dynamic programming approach.** Xu, Y.; Mural, R.J.; Uberbacher, E.C. Oak Ridge National Lab., TN (United States). Dec 1994. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95004223. Source: OSTI; NTIS; GPO Dep.

This paper presents an algorithm for detecting and "correcting" sequencing errors that occur in DNA coding regions. The types of sequencing error addressed include insertions and deletions (indels) of DNA bases. The goal is to provide a capability which makes single-pass or low-redundancy sequence data more informative, reducing the need for high-redundancy sequencing for gene identification and characterization purposes. The algorithm detects sequencing errors by discovering changes in the statistically preferred reading frame within a putative coding region and then inserts a number of "neutral" bases at a perceived reading frame transition point to make the putative exon candidate frame consistent. The authors have implemented the algorithm as a front-end subsystem of the GRAIL DNA sequence analysis system to construct a version which is very error tolerant and also intend to use this as a testbed for further development of sequencing error-correction technology. On a test set consisting of 68 Human DNA sequences with 1% randomly generated indels in coding regions, the algorithm detected and corrected 76% of the indels. The average distance between the position of an indel and the predicted one was 9.4 bases. With this subsystem in place, GRAIL correctly predicted 89% of the coding messages with 10% false message on the "corrected" sequences, compared to 69% correctly predicted coding messages and 11% falsely predicted messages on the "corrupted" sequences using standard GRAIL II method. The method uses a dynamic programming algorithm, and runs in time and space linear to the size of the input sequence.

5503 Cytology

6585 (DOE/ER/13426–T3) **Structural studies of complex carbohydrates of plant cell walls. Final report, December 15, 1989–June 14, 1993.** Darvill, A.G. Georgia Univ., Athens, GA (United States). Complex Carbohydrate Research Center. Oct 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG09-85ER13426. Order Number DE95003099. Source: OSTI; NTIS; GPO Dep.

Characterizing the polysaccharides that constitute the primary cell walls of plants and developing the methods for these characterizations has been a major research goal of our laboratory for many years. We have made considerable progress in both of these areas during the past three years. The cell walls of a plant determine the plant's structure and morphology and act as a barrier to pests. Cell walls also control the rate of growth of plant cells and are a source of complex carbohydrates with biological regulatory properties (oligosaccharins). The research projects supported by this grant concentrate on the isolation and structural characterization of the complex carbohydrates that account for approximately 70–80% of the primary cell walls of dicotyledons and non-graminaceous monocotyledons. Abstracts of papers published, in press, or in preparation reporting work supported by this grant during the past three years follow and summarize more fully the progress made in this research project.

5504 Genetics

Refer also to citation(s) 6012

6586 (CONF-9411116–) **DOE Human Genome Program: Contractor-Grantee Workshop IV, November 13–17, 1994, Santa Fe, New Mexico.** Oak Ridge National Lab., TN (United States). Oct 1994. 252p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From U.S. Department of Energy (DOE) human genome program contractor-grantee workshop; Santa Fe, NM (United States); 13-17 Nov 1994. Order Number DE95002230. Source: OSTI; NTIS; GPO Dep.

This volume contains the proceedings of the fourth Contractor-Grantee Workshop for the Department of Energy (DOE) Human Genome Program. Of the 204 abstracts in this book, some 200 describe the genome research of DOE-funded grantees and contractors located at the multidisciplinary centers at Lawrence Berkeley Laboratory, Lawrence Livermore National Laboratory, and Los Alamos National Laboratory; other DOE-supported laboratories; and more than 54 universities, research organizations, and companies in the United States and abroad. Included are 16 abstracts from ongoing projects in the Ethical, Legal, and Social Issues (ELSI) component, an area that continues to attract considerable attention from a wide variety of interested parties. Three abstracts summarize work in the new Microbial Genome Initiative launched this year by the Office of Health and Environmental Research (OHER) to provide genome sequence and mapping data on industrially important microorganisms and those that live under extreme conditions. Many of the projects will be discussed at plenary sessions held throughout the workshop, and all are represented in the poster sessions.

6587 (LA-UR–94-3972) **Technologies for large-scale physical mapping of human chromosomes.** Beugelsdijk, T.J. Los Alamos National Lab., NM (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950257–1: International conference on automation, robotics, and artificial intelligence, Montreaux (Switzerland), 7-10 Feb 1995). Order Number DE95003669. Source: OSTI; NTIS; GPO Dep.

Since its inception 6 years ago, the Human Genome Project has made rapid progress towards its ultimate goal of developing the complete sequence of all human chromosomes. This progress has been made possible through the development of automated devices by laboratories throughout the world that aid the molecular biologist in various phases of the project. The initial phase involves the generation of physical and genetic maps of each chromosome. This task is nearing completion at a low resolution level with several instances of very high detailed maps being developed for isolated chromosomes. In support of the initial mapping thrust of this program, the robotics and automation effort at Los Alamos National Laboratory has developed DNA gridding technologies along with associated database and user interface systems. This paper will discuss these systems in detail and focus on the formalism developed for subsystems which allow for facile system integration.

6588 (LBL–36154) **Genetic and metabolic influences on LDL subclasses.** Krauss, R.M. (Lawrence Berkeley Lab., CA (United States)); Rotter, J.I.; Lusis, A.J. Lawrence Berkeley Lab., CA (United States). Sep 1994. 10p. Sponsored by USDOE, Washington, DC (United States);Department of Health and Human Services, Washington, DC (United States);National Dairy Council, Rosemont, IL (United States). DOE Contract AC03-76SF00098. (CONF-9410255–1: 10. international symposium on atherosclerosis, Montreal (Canada), 10-14 Oct 1994). Order Number DE95003432. Source: OSTI; NTIS; GPO Dep.

Genetic and environmental factors influence LDL particle size and density, and expression of an atherogenic lipoprotein phenotype (ALP) characterized by predominance of small, dense LDL particles. Linkage of ALP the LDL receptor locus has been reported previously. Quantitative sib-pair relative-pair linkage methodologies

were used to test for linkage of LDL particle size to candidate loci in 25 large pedigrees with familial coronary artery disease. Linkage to the LDL receptor gene locus was confirmed (p=0.008). Evidence was also obtained for linkage to the genes for apoCIII, cholesteryl ester transfer protein, and manganese superoxide dismutase. The results suggest multiple genetic determinants of LDL particle size that may involve different metabolic mechanisms giving rise to small, dense LDL and increased atherosclerosis risk.

6589 (UCRL-JC–117919) **Statistical and computational challenges in physical mapping.** Nelson, D.O.; Speed, T.P. Lawrence Livermore National Lab., CA (United States). Jun 1994. 11p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9406290–1: 26. symposium on the interface: computer science and statistics, Triangle Park, NC (United States), 15-18 Jun 1994). Order Number DE95003658. Source: OSTI; NTIS; GPO Dep.

One of the great success stories of modern molecular genetics has been the ability of biologists to isolate and characterize the genes responsible for serious inherited diseases like Huntington's disease, cystic fibrosis, and myotonic dystrophy. Instrumental in these efforts has been the construction of so-called "physical maps" of large regions of human chromosomes. Constructing a physical map of a chromosome presents a number of interesting challenges to the computational statistician. In addition to the general ill-posedness of the problem, complications include the size of the data sets, computational complexity, and the pervasiveness of experimental error. The nature of the problem and the presence of many levels of experimental uncertainty make statistical approaches to map construction appealing. Simultaneously, however, the size and combinatorial complexity of the problem make such approaches computationally demanding. In this paper we discuss what physical maps are and describe three different kinds of physical maps, outlining issues which arise in constructing them. In addition, we describe our experience with powerful, interactive statistical computing environments. We found that the ability to create high-level specifications of proposed algorithms which could then be directly executed provided a flexible rapid prototyping facility for developing new statistical models and methods. The ability to check the implementation of an algorithm by comparing its results to that of an executable specification enabled us to rapidly debug both specification and implementation in an environment of changing needs.

5505 Metabolism

Refer also to citation(s) 5524

5506 Medicine

Refer also to citation(s) 5856, 6296, 6374, 6588, 7021

6590 (DOE/ER/60561–10) **Advancing PET science for new measures of brain function. Progress report, January 1, 1994–December 31, 1994.** Kuhl, D.E. Michigan Univ., Ann Arbor, MI (United States). Oct 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER60561. Order Number DE95004305. Source: OSTI; NTIS; INIS; GPO Dep.

This project has continued the development of new chemistry and imaging physics applicable to PET studies of the human brain. In basic radiochemistry research, the authors have developed a modified approach to solid-phase supported [^{11}C]methylation system, in part dependent on the design, fabrication and validation of new small, sensitive and accurate positron detectors useful in tracking the flow of radioactivity through the synthesis apparatus. Radiopharmaceutical efforts have resulted in synthesis of new tracers of mitochondrial enzymes. For evaluation of new PET radiotracers, the authors have applied new models of unilateral brain lesions using quinolinic acid and MPP+, as models of neurodegenerative diseases. In the physics and data analysis research area the authors have developed faster and more accurate means of performing image reconstruction for use with both emission and transmission data. The authors are optimizing acquisition and kinetic modeling strategies for new radiotracers. The authors also have implemented and proven the utility of performing task switching during PET CBF activation studies for the purpose of enhancing signal-to-noise and greater detectability of areas of activation. The authors also working on routines for standardization of analysis strategies for group vs. group and individual vs. group comparisons.

6591 (JAERI-M–94-019, pp. 104-112) **Atomic, molecule's and nuclear data for medical application.** Iwanami, Shigeru (Kitasato Univ., Sagamihara, Kanagawa (Japan). School of Medicine). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

Medical physicists need atomic and nuclear data. What kinds of data do they need? One answer is 'JARP Medical Physics Data Book'. So we introduce this DATA BOOK as a typical example of atomic, molecule's and nuclear data for medical applications. (author).

6592 (JAERI-M–94-019, pp. 154-157) **Needs of atomic, molecule's and nuclear data for medical application in Japan.** Iwanami, Shigeru (Kitasato Univ., Sagamihara, Kanagawa (Japan). School of Medicine). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

There are large potential needs of atomic and nuclear data for medical applications in Japan. But number of medical physicists who need their data is very small. The status of medical physicist does not formally exist in Japanese hospitals. Then practical needs for atomic and nuclear data are small in Japan. (author).

6593 (LA-UR–94-3978) **Taylor series expansion and modified extended Prony analysis for localization.** Mosher, J.C.; Lewis, P.S. Los Alamos National Lab., NM (United States). [1994]. 5p. Sponsored by Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9410156–3: 28. annual Asilomar conference on signals, systems, and computers, Pacific Grove, CA (United States), 31 Oct - 2 nov 1994). Order Number DE95003671. Source: OSTI; NTIS; GPO Dep.

In the multiple source localization problem, many inverse routines use a rooting of a polynomial to determine the source locations. The authors present a rooting algorithm for locating an unknown number of three-dimensional, near-field, static sources from measurements at an arbitrarily spaced three-dimensional array. Since the sources are near-field and static, the spatial covariance matrix is always rank one, and spatial smoothing approaches are inappropriate due to the spatial diversity. The authors approach the solution through spherical harmonics, essentially replacing the point source function with its Taylor series expansion. They then perform a modified extended Prony analysis of the expansion coefficients to determine the number and location of the sources. The full inverse method is typically ill-conditioned, but a portion of the algorithm is suitable for synthesis analysis. They present a simulation for simplifying point charges limited to a spherical region, using an array of voltage potential measurements made outside the region. Future efforts of this work will focus on adapting the analysis to the electroencephalography and magnetoencephalography.

6594 (LBL–35540) **Electrostatic quadrupole DC accelerators for BNCT applications.** Kwan, J.W.; Anderson, O.A.; Reginato, L.L.; Vella, M.C.; Yu, S.S. Lawrence Berkeley Lab., CA (United States). Apr 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-940976–2: 1. International workshop on accelerator-based neutron sources for boron neutron capture therapy, Jackson, WY (United States), 11-14 Sep 1994). Order Number DE95003435. Source: OSTI; NTIS; INIS; GPO Dep.

A dc electrostatic quadrupole (ESQ) accelerator is capable of producing a 2.5 MeV, 100 mA proton beam for the purpose of generating neutrons for Boron Neutron Capture Therapy. The ESQ accelerator is better than the conventional aperture column in high

beam current application due to the presence of stronger transverse field for beam focusing and for suppressing secondary electrons. The major challenge in this type of accelerator is in developing the proper power supply system.

6595 (NUREG/CP–0133-Vol.1, pp. 229-252) **An examination of human factors in external beam radiation therapy: Findings and implications.** Henriksen, K.; Kaye, R.D.; Jones, R.E. Jr.; Morisseau, D.S.; Persensky, J.J. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

To better understand the contributing factors to human error in external beam radiation therapy, the US Nuclear Regulatory Commission has undertaken a series of human factors evaluations. A team of human factors specialists, assisted by a panel of radiation oncologists, medical physicists, and radiation technologists, conducted visits to 24 radiation oncology departments at community hospitals, university centers, and free-standing clinics. A function and task analysis was initially performed to guide subsequent evaluations in the areas of human-system interfaces, procedures, training and qualifications, and organizational policies and practices. Representative findings and implications for improvement are discussed within the context of a dynamic model which holds that misadministration likely results from the unanticipated interaction of several necessary but singly insufficient conditions.

6596 (NUREG/CP–0133-Vol.1, pp. 253-272) **Human error in remote Afterloading Brachytherapy.** Quinn, M.L. (Pacific Science and Engineering Group Inc., San Diego, CA (United States)); Callan, J.; Schoenfeld, I.; Serig, D. Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research; Brookhaven National Lab., Upton, NY (United States). Apr 1994. (CONF-931079–Vol.1: 21. water reactor safety information meeting, Bethesda, MD (United States), 25-27 Oct 1993). In *Proceedings of the Twenty-First Water Reactor Safety Information Meeting: Volume 1, Plenary session; Advanced reactor research; advanced control system technology; advanced instrumentation and control hardware; human factors research; probabilistic risk assessment topics; thermal hydraulics; thermal hydraulic research for advanced passive LWRs.* 586p. Source: OSTI; NTIS; INIS; GPO.

Remote Afterloading Brachytherapy (RAB) is a medical process used in the treatment of cancer. RAB uses a computer-controlled device to remotely insert and remove radioactive sources close to a target (or tumor) in the body. Some RAB problems affecting the radiation dose to the patient have been reported and attributed to human error. To determine the root cause of human error in the RAB system, a human factors team visited 23 RAB treatment sites in the US. The team observed RAB treatment planning and delivery, interviewed RAB personnel, and performed walk-throughs, during which staff demonstrated the procedures and practices used in performing RAB tasks. Factors leading to human error in the RAB system were identified. The impact of those factors on the performance of RAB was then evaluated and prioritized in terms of safety significance. Finally, the project identified and evaluated alternative approaches for resolving the safety significant problems related to human error.

6597 (SAND–94-2707C) **Application of HTS technology to cardiac dysrhythmia detection.** Sobel, A.L. (Sandia National Labs., Albuquerque, NM (United States)); Avrin, W.F. Sandia National Labs., Albuquerque, NM (United States). [1994]. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941119–1: 16. annual international conference of the Engineering in Medicine and Biology Society, Baltimore, MD (United States), 3-6 Nov 1994). Order Number DE95003359. Source: OSTI; NTIS; GPO Dep.

This paper discusses the conceptual design considerations and challenges for development of a contactless, mobile, single channel biomagnetic sensor system based on High-Temperature Superconductor (HTS) Superconducting Quantum Interference Devices (SQUIDs) and employing the Three-SQUID Gradiometer (TSG) concept. Operating in magnetically unshielded environments, as are encountered in many medical scenarios, this instrument class would monitor cardiac electrical activity with minimal patient preparation and intrusiveness, and would notionally be coupled with a clinically adaptive human-system interface (HSI).

5520 Public Health

Refer also to citation(s) 6576

5530 Agriculture and Food Technology

6598 (INIS-mf–14404) **CICTAMEX Memory 1991.** Centro de Investigaciones Cientificas y Tecnologicas del Aguacate en el Estado de Mexico (CICTAMEX), Coatepec Harinas (Mexico). 1991. 202p. (In Spanish). Order Number DE95609880. Source: OSTI; NTIS (US Sales Only); INIS.

The avocado agriculture industry at National and International levels is confronted to low yields which are due among other aspects to the high costs of products originated by the height of the tree as well as its foliage which difficults the harvest, low cultural customs of the harvesters and to the overrating of the phyto sanitary control. This has been originated by the actual research trends over avocado at all world level since the research has been oriented to the obtention of dwarf tree varieties with the advantages that this offers. The Salvador Sanchez Colin CICTAMEX Foundation is developing a genetic improvement program with the support of the Instituto Nacional de Investigaciones Nucleares (ININ) by means of the pacific uses of nuclear energy on fruits principally the avocado.

6599 (INIS-mf–14405) **CICTAMEX Memory 1992.** Centro de Investigaciones Cientificas y Tecnologicas del Aguacate en el Estado de Mexico. Centro de Investigaciones Cientificas y Tecnologicas del Aguacate en el Estado de Mexico (CICTAMEX), Coatepec Harinas (Mexico). 1992. 237p. (In Spanish). Order Number DE95609881. Source: OSTI; NTIS (US Sales Only); INIS.

The avocado agriculture industry at National and International levels is confronted to low yields which are due among other aspects to the high costs of products originated by the height of the tree as well as its foliage which difficults the harvest, low cultural customs of the harvesters and to the overrating of the phyto sanitary control. This has been originated by the actual research trends over avocado at all world level since the research has been oriented to the obtention of dwarf tree varieties with the advantages that this offers. The Salvador Sanchez Colin CICTAMEX Foundation is developing a genetic improvement program with the support of the Instituto Nacional de Investigaciones Nucleares (ININ) by means of the pacific uses of nuclear energy on fruits principally the avocado.

6600 (SAND–94-2149C) **The use of electron beams for pasteurization of meats.** Prestwich, K.R.; Kaye, R.J.; Turman, B.N.; Neau, E.L. Sandia National Labs., Albuquerque, NM (United States). [1994]. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9409266–1: 1994 American meat industry research conference, San Francisco, CA (United States), 29 Sep - 1 oct 1994). Order Number DE95003352. Source: OSTI; NTIS; INIS; GPO Dep.

Electron beam accelerators can be used for electronic pasteurization of meat products by: (1) using the electrons directly impacting the products, or (2) optimizing the conversion of electron energy to x-rays and treating the product with these x-rays. The choice of process depends on the configuration of the product when it is treated. For electron treatment, ten million electron volt (MeV) kinetic energy is the maximum allowed by international agreement. The depth of penetration of electrons with that energy into a product with density of meat is about five centimeters (cm). Two-sided treatment can be done on products up to 10 cm thick with a two-to-one ratio between minimum and maximum dose.

Ground beef patties are about 1.25 cm (0.5 inch thick). Beams with 2.5 MeV electron energy could be used to treat these products. Our calculations show that maximum to minimum dose ratios less than 1.2 can be achieved with this energy if the transverse beam energy is small. If the product thickness is greater than 10 cm, x-rays can provide the needed dose uniformity. Uniform doses can be supplied for pallets with dimensions greater than 1.2 m on each side using x-rays from a 5 MeV electron beam. The efficiency of converting the electron beam to x-rays and configurations to achieve dose uniformity are discussed.

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 5175, 5362, 5397, 5420, 5432, 5750, 5827, 5828, 5891, 5892, 6541, 6575, 6595

6601 (CIEMAT–747) **Modeling the systemic retention of beryllium in rat. Extrapolation to human.** Montero Prieto, M.; Vidania Muoz, R. de. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 36p. (In Spanish). Order Number DE95722441. Source: OSTI; NTIS; INIS.

In this work, we analyzed different approaches, assayed in order to numerically describe the systemic behaviour of Beryllium. The experimental results used in this work, were previously obtained by Furchner et al. (1973), using Sprague-Dawley rats, and other animal species. Furchner's work includes the obtained model for whole body retention in rats but not for each target organ. In this work we present the results obtained by modeling the kinetic behaviour of Beryllium in several target organs. The results of this kind of models were used in order to establish correlations among the estimated kinetic constants. The parameters of the model were extrapolated to humans and, finally, compared with other previously published.

6602 (CONF-9304128–) **1993 Radiation Protection Workshop: Proceedings.** USDOE Assistant Secretary for Environment, Safety, and Health, Washington, DC (United States). Office of Health; USDOE Nevada Field Office, Las Vegas, NV (United States). [1993]. 431p. Sponsored by USDOE, Washington, DC (United States). From Department of Energy (DOE) radiation protection conference; Las Vegas, NV (United States); 13-15 Apr 1993. Order Number DE95004507. Source: OSTI; NTIS; INIS; GPO Dep.

The 1993 DOE Radiation Protection Workshop was conducted from April 13 through 15, 1993 in Las Vegas, Nevada. Over 400 Department of Energy Headquarters and Field personnel and contractors from the DOE radiological protection community attended the Workshop. Forty-nine papers were presented in eleven separate sessions: Radiological Control Manual Implementation, New Approaches to Instrumentation and Calibration, Radiological Training Programs and Initiatives, External Dosimetry, Internal Dosimetry, Radiation Exposure Reporting and Recordkeeping, Air Sampling and Monitoring Issues, Decontamination and Decommissioning of Sites, Contamination Monitoring and Control, ALARA/ Radiological Engineering, and Current and Future Health Physics Research. Individual papers are indexed separately on the database.

6603 (DOE-HDBK–1079-94) **Primer on tritium safe handling practices.** USDOE, Washington, DC (United States). Dec 1994. 38p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003577. Source: OSTI; NTIS; GPO Dep.

This Primer is designed for use by operations and maintenance personnel to improve their knowledge of tritium safe handling practices. It is applicable to many job classifications and can be used as a reference for classroom work or for self-study. It is presented in general terms for use throughout the DOE Complex. After reading it, one should be able to: describe methods of measuring airborne tritium concentration; list types of protective clothing effective against tritium uptake from surface and airborne contamination; name two methods of reducing the body dose after a tritium uptake; describe the most common method for determining amount of tritium uptake in the body; describe steps to take following an accidental release of airborne tritium; describe the damage to metals that results from absorption of tritium; explain how washing hands or showering in cold water helps reduce tritium uptake; and describe how tritium exchanges with normal hydrogen in water and hydrocarbons.

6604 (DOE/NV–374) **Development of the town data base: Estimates of exposure rates and times of fallout arrival near the Nevada Test Site.** Thompson, C.B. (Univ. and Community College System of Nevada, Las Vegas, NV (United States)); McArthur, R.D.; Hutchinson, S.W. Nevada Univ., Reno, NV (United States). Desert Research Inst. Sep 1994. 130p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC08-85NV10384 ; AC08-90NV10845. Order Number DE95004398. Source: OSTI; NTIS; INIS; GPO Dep.

As part of the U.S. Department of Energy's Off-Site Radiation Exposure Review Project, the time of fallout arrival and the H+12 exposure rate were estimated for populated locations in Arizona, California, Nevada, and Utah that were affected by fallout from one or more nuclear tests at the Nevada Test Site. Estimates of exposure rate were derived from measured values recorded before and after each test by fallout monitors in the field. The estimate for a given location was obtained by retrieving from a data base all measurements made in the vicinity, decay-correcting them to H+12, and calculating an average. Estimates were also derived from maps produced after most events that show isopleths of exposure rate and time of fallout arrival. Both sets of isopleths on these maps were digitized, and kriging was used to interpolate values at the nodes of a 10-km grid covering the pattern. The values at any location within the grid were then estimated from the values at the surrounding grid nodes. Estimates of dispersion (standard deviation) were also calculated. The Town Data Base contains the estimates for all combinations of location and nuclear event for which the estimated mean H+12 exposure rate was greater than three times background. A listing of the data base is included as an appendix. The information was used by other project task groups to estimate the radiation dose that off-site populations and individuals may have received as a result of exposure to fallout from Nevada nuclear tests.

6605 (EPA–520/1-87-023) **An analysis of evacuation options for nuclear accidents.** Tawil, J.J. (Battelle Memorial Inst., Richland, WA (United States)); Strenge, D.L.; Schultz, R.W. Environmental Protection Agency, Washington, DC (United States); Battelle Memorial Inst., Richland, WA (United States). Nov 1987. 246p. Sponsored by Environmental Protection Agency, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95005270. Source: OSTI; NTIS; GPO Dep.

In this report we consider the threat posed by the accidental release of radionuclides from a nuclear power plant. The objective is to establish relationships between radiation dose and the cost of evacuation under a wide variety of conditions. The dose can almost always be reduced by evacuating the population from a larger area. However, extending the evacuation zone outward will cause evacuation costs to increase. The purpose of this analysis was to provide the Environmental Protection Agency (EPA) a data base for evaluating whether implementation costs and risks averted could be used to justify evacuation at lower doses. The procedures used and results of these analyses are being made available as background information for use by others. We develop cost/dose relationships for 54 scenarios that are based upon the severity of the reactor accident, meteorological conditions during the release of radionuclides into the environment, and the angular width of the evacuation zone. The 54 scenarios are derived from combinations of three accident severity levels, six meteorological conditions and evacuation zone widths of 70°, 90°, and 180°.

6606 (INP–1558/AP) **Radiological hazard from coal-fired power plants in Poland.** Nowina-Konopka, M. (Institute of Nuclear Physics, Cracow (Poland)). Institute of Nuclear Physics, Cracow (Poland). 1991. 31p. (In Polish). Order Number DE95610948. Source: OSTI; NTIS; INIS.

The radiobiological hazard of Polish population due to coal combustion for electric power production was assessed. Activity concentrations of the elementary radionuclides in coal and all kinds of ashes were measured. The ATMO computer program was applied to calculate the annual increase of the activity concentration in the air and of the annual increase of activity falling on the ground. Exposition by inhalation, oral ingestion and external irradiation was taken into account. The assessed value of irradiation was taken into account. The assessed value of individual effective dose equivalent commitments for the critical group is 0.1 mSv, i.e. 4% of the total dose rate from natural radiation. The collective effective dose equivalent commitments received of all sources by an inhabitant of Poland as a consequence of annual coal combustion in Polish CPP is 367 manSv/a (i.e. 47 manSv per GWa), i.e. 0.4% of the dose from natural radiation. (author). 11 refs, 3 figs, 8 tabs.

6607 (LUNBDS-NBFB–1028/1-88(1994)) **Effects of ultraviolet radiation on microtubule organisation and morphogenesis in plants.** Staxen, I. Lund Univ. (Sweden). Dept. of Plant Physiology. Sep 1994. 44p. Order Number DE95609825. Source: OSTI; NTIS; INIS.

The involvement of the cytoskeleton in the development of somatic embryos was studied in Larix x eurolepis. Protoplasts were isolated from both somatic embryo-regenerating and non-generating cultures and fractionated on a discontinuous Percoll density gradient. Protoplasts of two cell lines of Larix eurolepis, one with regenerating potential and one lacking this potential, were compared. In contrast to the non-regenerating line were a protoplast-like organisation of the cortical microtubules was maintained, re-organisation of this microtubular network occurred in the regenerable line after only three days of culture, indicating that organised growth was occurring. However, this early organisation of cortical microtubules may not always be a valid marker for regenerable and non-regenerable material. In order to investigate the effect of ultraviolet-B (UV-B, 280-320 nm) radiation on the microtubule cytoskeleton, protoplasts were isolated from leaves of Petunia hybrida and subjected to four different doses of UV-B radiation. The organisation of the microtubules and the progression of the cells through the cell cycle was observed at 0, 24, 48 and 72 h after irradiation. UV-B induced breaks in the cortical microtubules resulting in shorter fragments with increasing amounts of radiation. Also, the division of the protoplasts was delayed. Whole Petunia plants were grown in growth chambers in the presence and absence of UV-B. The plants responded to UV-B with increased rates of CO_2 assimilation, a 60% increase in UV-screening compounds and the changes in the morphology of the leaves that were reflected in a 70-100% increase in leaf area and 20% decrease in leaf thickness. The microtubules of the epidermal cells was not affected by UV-B, nor was the number of epidermal cells (per unit area). The increase in leaf area in the UV-treated plants appeared due to stimulation of cell division in the leaf meristems. 111 refs, 5 figs, 2 tabs.

6608 (NAHRES–15) **Application of stable isotope tracer methods to studies of amino acid, protein, and energy metabolism in malnourished populations of developing countries. Report of an IAEA consultants' meeting held in Vienna, Austria, 14-16 December 1992.** International Atomic Energy Agency, Vienna (Austria). Section of Nutritional and Health-Related Environmental Studies. 1993. 31p. (CONF-9212129–: IAEA consultants' meeting on the application of stable isotope tracer methods to studies of amino acid, protein, and energy metabolism in malnourished populations of developing countries, Vienna (Austria), 14-16 Dec 1992). Order Number DE95609870. Source: OSTI; NTIS (US Sales Only); INIS.

A Consultants' Meeting convened by the IAEA in December 1992, made recommendations on the organization of a Co-ordinated Research Programme (CRP) using stable isotopic techniques for international comparative studies of amino acid, protein, and energy metabolism in chronically undernourished people. The CRP will use recent developments in stable isotope tracer techniques (^{13}C and ^{15}N) to assess the impact of infection in undernourished people on the kinetics of protein breakdown, protein synthesis, amino acid metabolism, and on the synthetic rates of selected plasma proteins. Studies will be conducted in developing countries, particularly in young children. The programme goals are to (i) elaborate methods and model protocols which can be implemented in developing countries to investigate the impact on protein metabolism of infection superimposed on chronic undernutrition; (ii) test they hypothesis that dietary requirements for protein and amino acids are related to the place of nutrition and are altered substantially when infection is superimposed on chronic undernutrition. When feasible, the primary focus on protein/amino acid metabolism will be extended to assessments of protein/energy interactions when $H_2{}^{18}O$ becomes more readily available and/or at research sites with indirect calorimetry equipment. The data generated should be appropriate as a basis for reevaluating amino acid/protein requirements in these populations. Refs.

6609 (NEI-NO–440) **International harmonization of intervention levels.** Jensen, P.H. (Risoe National Lab., Roskilde (Denmark)). No corporate text available. May 1994. 14p. (CONF-9405256–: Nordic seminar on emergency preparedness in nuclear accidents, Oslo (Norway), 4-6 May 1994). Order Number DE95609903. Source: OSTI; NTIS (US Sales Only); INIS.

A summary is given on international guidance on intervention levels in circumstances in which remedial actions might be considered in nuclear accident situations. The nature and limitations of international work and their effect on the resulting guidance are discussed. The basic international principles recommended can be expressed in the following compressed form: (1) serious deterministic effects should be avoided by intervention, (2) each protective measure should be justified, i.e. do more good than harm, (3) the level at which the protective measures are to be introduced should be optimized, i.e. do most good, and (4) each protective measure should be optimized separately and independent of all other countermeasures. It is of great importance that decision makers inform the public of all aspects of their decisions in order to make the decisions transparent, especially when the interventions chosen are mainly for political or social reason rather than health protection grounds. Otherwise the public may be misled and the radiological protection community will be mistrusted. 17 refs., 6 tabs.

6610 (NEI-NO–441) **Intervention principles and levels in the event of a nuclear accident. Final report on the Nordic Nuclear Safety Research Project BER-3.** Walmod-Larsen, O. (Risoe National Lab., Roskilde (Denmark)). No corporate text available. Apr 1994. 8p. (CONF-9405256–: Nordic seminar on emergency preparedness in nuclear accidents, Oslo (Norway), 4-6 May 1994). Order Number DE95609904. Source: OSTI; NTIS (US Sales Only); INIS.

The aim of the Nordic BER-3 project has been to harmonize the Nordic intervention levels after a nuclear accident. The paper deals with the findings and recommendations to be presented to the Nordic authorities as background material for common decisions on the most likely protective actions. In the report sheltering, evaluation and relocation are treated in detail. Iodine prophylaxis and foodstuff restrictions are briefly commented on. The basis for this work is the internationally accepted basic principles for interventions.

6611 (NEI-NO–443) **Nordic nuclear emergency exercises. Final report of the BER-5 project.** Bennerstedt, T. (NKS, Roskilde (Denmark)); Stranden, E.; Salo, A. No corporate text available. May 1994. 6p. (CONF-9405256–: Nordic seminar on emergency preparedness in nuclear accidents, Oslo (Norway), 4-6 May 1994). Order Number DE95609905. Source: OSTI; NTIS (US Sales Only); INIS.

In all Nordic countries, nuclear emergency provisions have been revised following the Chernobyl accident. Local and national exercises are carried out regularly in each of the countries. Several actions have been taken to harmonize the approaches of individual Nordic countries. In order to further promote similar decision making procedures in an emergency situation, two Nordic exercises were conducted in 1993. It was important to see if all five countries (Denmark, Finland, Iceland, Norway and Sweden) responded in a similar way to a given situation, as far as risk assessment and countermeasures were concerned. The exercises were mainly aimed at decision makers and advisers of the five national emergency organizations. Thus, the exercises did not include comparison of underlying calculations on, e.g., atmospheric trajectories or transfer of radioactive material from air to ground. Such functions were tested separately in drills that formed part of the overall

Nordic emergency preparedness program. It turned out that considerable effort is required to prepare exercises of this kind and magnitude. In each country, a national exercise leader was appointed. A Nordic evaluation team was set up. Common rules for the simulated inputs during the exercise and for the evaluators were decided on. The scenarios were prepared by an independent group. An essential planning item is the coordination of the Nordic exercises with those performed on a more routine basis in each country. The exercises included an acute-phase situation (NORA), and a late-phase situation (ODIN).

6612 (NIRS-M–97) **Human · mouse genome analysis and radiation biology. Proceedings.** Hori, Tada-aki (ed.). National Inst. of Radiological Sciences, Chiba (Japan). Mar 1994. 288p. (In Japanese, English). (CONF-9311277–: 25. NIRS symposium, Chiba (Japan), 18-19 Nov 1993). Order Number DE95737283. Source: OSTI; NTIS; INIS.

This issue is the collection of the papers presented at the 25th NIRS symposium on Human, Mouse Genome Analysis and Radiation Biology. The 14 of the presented papers are indexed individually. (J.P.N.).

6613 (NUREG–0090-Vol.17-No.2) **Report to Congress on abnormal occurrences, April–June 1994: Volume 17, Number 2.** Nuclear Regulatory Commission, Washington, DC (United States). Office for Analysis and Evaluation of Operational Data. Oct 1994. 30p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

Section 208 of the Energy Reorganization Act of 1974 identifies an abnormal occurrence (AO) as an unscheduled incident or event that the Nuclear Regulatory Commission determines to be significant from the standpoint of public health or safety and requires a quarterly report of such events to be made to Congress. This report provides a description of those events that have been determined to be abnormal occurrences during the period of April 1 through June 30, 1994. This report addresses seven abnormal occurrences (AOs) at NRC-licensed facilities. Five involved medical brachytherapy misadministrations, one involved a medical teletherapy misadministration, and one involved a medical sodium iodide misadministration. Four AOs were reported by the Agreement States as of August 3, 1994. Two involved medical brachytherapy misadministrations, one involved a radiation burn received by an industrial radiographer, and one involved a lost well logging source. The report also contains updates of seven AOs previously reported by NRC licensees and five AOs previously reported by Agreement State licensees. Three "Other Events of Interest" are also reported. One involved a deliberate cover up of an error in a diagnostic radiopharmaceutical administration at an NRC licensee, one involved an Order Suspending License and Demand for Information at an NRC licensee, and one involved an overexposure of an industrial radiographer at an Agreement State licensee.

6614 (NUREG–0940-Vol.13-No.3-Pt.2) **Enforcement actions: Significant actions resolved, medical licensees. Quarterly progress report, July–September 1994: Volume 13, Number 3, Part 2.** Nuclear Regulatory Commission, Washington, DC (United States). Office of Enforcement. Dec 1994. 311p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

This compilation summarizes significant enforcement actions that have been resolved during one quarterly period (July–September 1994) and includes copies of letters, Notices, and Orders sent by the Nuclear Regulatory Commission to medical licensees with respect to these enforcement actions. It is anticipated that the information in this publication will be widely disseminated to managers and employees engaged in activities licensed by the NRC, so that actions can be taken to improve safety by avoiding future violations similar to those described in this publication.

6615 (PNL-SA–24011) **Estimates of bias and uncertainty in recorded external dose.** Fix, J.J.; Gilbert, E.S.; Baumgartner, W.V. Pacific Northwest Lab., Richland, WA (United States). Oct 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. (CONF-941017–4: 4. conference on radiation protection and dosimetry, Orlando, FL (United States), 24-27 Oct 1994). Order Number DE95003134. Source: OSTI; NTIS; INIS; GPO Dep.

A study is underway to develop an approach to quantify bias and uncertainty in recorded dose estimates for workers at the Hanford Site based on personnel dosimeter results. This paper focuses on selected experimental studies conducted to better define response characteristics of Hanford dosimeters. The study is more extensive than the experimental studies presented in this paper and includes detailed consideration and evaluation of other sources of bias and uncertainty. Hanford worker dose estimates are used in epidemiologic studies of nuclear workers. A major objective of these studies is to provide a direct assessment of the carcinogenic risk of exposure to ionizing radiation at low doses and dose rates. Considerations of bias and uncertainty in the recorded dose estimates are important in the conduct of this work. The method developed for use with Hanford workers can be considered an elaboration of the approach used to quantify bias and uncertainty in estimated doses for personnel exposed to radiation as a result of atmospheric testing of nuclear weapons between 1945 and 1962. This approach was first developed by a National Research Council (NRC) committee examining uncertainty in recorded film badge doses during atmospheric tests (NRC 1989). It involved quantifying both bias and uncertainty from three sources (i.e., laboratory, radiological, and environmental) and then combining them to obtain an overall assessment. Sources of uncertainty have been evaluated for each of three specific Hanford dosimetry systems (i.e., the Hanford two-element film dosimeter, 1944-1956; the Hanford multi-element film dosimeter, 1957-1971; and the Hanford multi-element TLD, 1972-1993) used to estimate personnel dose throughout the history of Hanford operations. Laboratory, radiological, and environmental sources of bias and uncertainty have been estimated based on historical documentation and, for angular response, on selected laboratory measurements.

6616 (RPII–94/4) **Code of practice for radiological protection in dentistry.** Radiological Protection Inst. of Ireland (Ireland). Nov 1994. 17p. Order Number DE95610983. Source: OSTI; NTIS (US Sales Only); INIS.

This code of practice deals with the use of x-rays in dentistry. It replaces a code published by the Department of Health in 1988. 1 ref., 2 tabs.

6617 (STUK/ST-GUIDE–4.2) **Radiation meters for civil defence.** Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). 1994. 14p. Translation. The original text in Finnish which is published under the same guide number. The guide is valid from 1 January 1992 and will remain in force until further notice. It replaces the SS guide 5.2 issued on 30 May 1986. Order Number DE95610991. Source: OSTI; NTIS; INIS.

The technical requirements for the radiation meters used in civil defence are specified in the guide. The aim of the requirements is to quarantee sufficient measurement accuracy and reliable operation even in extreme environmental conditions. The guide is based on the following standards: (1) IEC 846 'Beta, X and gamma radiation dose equivalent and dose equivalent rate meters for use in radiation protection', (2) IEC 1017-1 'Portable, transportable of installed X or gamma radiation ratemeters for environmental monitoring, part 1: Ratemeters', and (3) IEC 45 B (Secretariat) 104 'Direct reading, personnel dose equivalent and/or dose equivalent rate monitors for X, gamma and high energy beta radiation'. (12 refs., 5 tabs.).

6618 (STUK/ST-GUIDE–12.2) **The radioactivity of construction materials, fuel peat and peat ash.** Finnish Centre for Radiation and Nuclear Safety (STUK), Helsinki (Finland). 1994. 7p. Translation of the original text in Finnish which is published under the same guide number. The guide is valid from 1 January 1992 and will remain in force until further notice. It replaces the SS guide 5.2 issued on 30 May 1986. Order Number DE95610990. Source: OSTI; NTIS; INIS.

The guide presents safety requirements related to radiation exposure from building materials and materials used in road and related construction. It also covers the safety requirements for the production of fuel peat and the handling and disposal of peat ash. Guidelines are also given for maintaining the required safety level. (5 refs.).

6619 (UCRL-CR–116511-94-3) **Use of international data sets to evaluate and validate pathway assessment models applicable to exposure and dose reconstruction at DOE facilities. Progress report, March–May 1994.** Anspaugh, L.R. (Lawrence Livermore National Lab., CA (United States)); Hendrickson, S.M. (eds.); Hoffman, F.O. Lawrence Livermore National Lab., CA (United States); Senes Oak Ridge, Inc., TN (United States). Center for Risk Analysis. 1 Jun 1994. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE94017511. Source: OSTI; NTIS; GPO Dep.

The project described in this report was the result of a Memorandum of Cooperation between the US and the former-USSR following the accident at the Chernobyl Nuclear Power Plant Unit 4. A joint program was established to improve the safety of nuclear power plants and to understand the implications of environmental releases. The task of Working Group 7 was "to develop jointly methods to project rapidly the health effects of any future nuclear reactor accident." The current objective of this project is to evaluate and validate pathway-assessment models applicable to exposure and dose reconstruction at DOE facilities through use of international data sets. This project incorporates data used for the prediction of radionuclide transfer through agricultural and aquatic systems to humans. It also includes participation in two multinational studies, BIOMOVS (Biospheric Model Validation Study) with the Swedish National Institute for Radiation Protection and VAMP (Validation of Model Predictions) with the International Atomic Energy Agency, that address testing the performance of models of radionuclide transport through foodchains. In the future, this project will be considered separately from the Chernobyl Studies Project and the essential activities of former Task 7.1D will be folded within the broader umbrella of the BIOMOVS and VAMP projects. The Working Group Leader of Task 7.1D will continue to provide oversight for this project.

6620 (WSRC-MS–94-0404) **Exposure reductions encouraged by the determination of the effective dose equivalent for non-uniform exposures.** Matheny, M.D.; Brown, C.G.; Dyer, S.G. Westinghouse Savannah River Co., Aiken, SC (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC09-89SR18035. (CONF-941017–1: 4. conference on radiation protection and dosimetry, Orlando, FL (United States), 24-27 Oct 1994). Order Number DE94016962. Source: OSTI; NTIS; INIS; GPO Dep.

DOE Order 5480.11 requires calculation of the effective dose equivalent (EDE) due to non-uniform radiation fields using ICRP-26 weighting factors. To comply with this requirement, Westinghouse Savannah River Company (WSRC) developed a simple dose calculation scheme based on a draft report by the External Dosimetry Working Group of the Health Physics Society Standards Committee. The calculations involved are fairly simple and provide a conservative dose estimate. The resulting EDE estimate provides a much better representation of the risk to the monitored individual than the more prevalent practice of assigning the highest measured dose. Details of the dose assessment methodology are included as an attachment.

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 4888, 5174, 5359, 5551, 6269, 6527, 6549

6621 (DOE/CH/10093–245, pp. 163-171) **Potential health risks of gasoline oxygenated with methyl tertiary butyl ether.** Graham, J.A. (Environmental Protection Agency, Research Triangle Park, NC (United States)); Davis, J.M.; Gerrity, T.R. National Renewable Energy Lab., Golden, CO (United States). May 1994. (CONF-9311211–Add.: 10. international symposium on alcohol fuels, Colorado Springs, CO (United States), 7-10 Nov 1993). In *Addendum: Tenth International Symposium on Alcohol Fuels, The road to commercialization.* 341p. Order Number DE93018219. Source: OSTI; NTIS.

The 1990 Clean Air Act Amendments mandated the use of oxygenated gasoline during the winter months, beginning November 1, 1992, in areas of the United States that did not attain the carbon monoxide health standards. Methyl tertiary butyl ether (MTBE) at about 15% by volume was the predominant oxygenate used to meet this mandate. Individuals in a few areas of the country reported health symptoms (e.g., headaches, eye irritation, nose irritation) they they associated with MTBE oxyfuel use. These reports prompted a large, rapid-response research program to investigate certain issues related to the potential health risks of MTBE. All of the available health effects and exposure data were assessed by the Office of Research and Development of the U.S. Environmental Protection Agency. This paper briefly describes the results of that assessment, focusing on the potential for acute exposure risks, chronic noncancer risks, and chronic cancer risks.

6622 (DOE/EV/10449–T2) **Toxic organic compounds from energy production: Final report.** Hites, R.A. Indiana Univ. Foundation, Bloomington, IN (United States). Aug 1988. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract Contract AC02-80EV10449. Source: OSTI; NTIS.

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The DOE's Office of Health and Environmental Research has supported a program in Professor Hites' laboratory since 1977. The theme of this program has been identifying potentially toxic organic compounds associated with various combustion effluents, following the fates of these compounds in the environment, and improving the analytical methodology for making these measurements. We have focused on groups of compounds known to be toxic and known to be associated with energy production. These include the polyhalogenated dioxins which are produced by the combustion of refuse derived fuel and polycyclic aromatic hydrocarbons which are produced by the combustion of almost anything. Our study of the fates of these compounds has lead us into photochemistry and indoor air pollution. 7 refs., 12 figs., 2 tabs.

6623 (ETDE/DE-mf–95726859) **Environmental impact and health. Research on risk assessment of environmental substances and other environmental factors for human health.** Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Referat fuer Presse und Oeffentlichkeitsarbeit. Mar 1994. 112p. (In German). Order Number DE95726859. Source: OSTI; NTIS (US Sales Only).

The health of the human being depends essentially on the fact whether it can be managed to form the environment in a way that the strains are reduced to an agreeable extent. The knowledge of material strains as well as the effect of environmental substances on the human being is the prerequisite. An essential goal of this promotion concept is to recognize noxious environmental impacts early to estimate risks for health and to elaborate contributions for avoiding potential noxious environmental impacts. The promotion concept is part of a primary programme 'environmental research and environmental technology' and supplements the programme 'health research in 2000'. In the first part, the reasons and effects of environmental impacts on the human being are described. After a balance of a previous project promotion, research goals, research facilities and working priorities are presented. In the appendix, BMFT promotion measures are introduced related to the subject. (UHE)

6624 (ETDE/DE-mf–95726879) **Terrestrial investigation of forest damages. Tasks, methods and importance.** Bundesministerium fuer Ernaehrung, Landwirtschaft und Forsten, Bonn (Germany). Oct 1993. 32p. (In German). Order Number DE95726879. Source: OSTI; NTIS (US Sales Only).

In the past, the critical situation in the forests could be recognized and present covering the area by means of a terrestrial inquiry of forest damage. Therefore its is a indispensible part of a complex environmental control in the future. Important impulses for the stepwise establishment of a research regarding forest damage started from the inquiry of forest damage. This brochure describes tasks, methods and the status of this inquiry, where the assessment of the state of the top is deatl with the detail in words and pictures. The addresses of the major forestry offices are listed. (UHE)

6625 (ETDE/DE-mf–95726966) **Influence of controlled soil acidification and compensatory liming in the 'Hoeglwald' on the nitrogen and carbohydrate metabolism of very fine roots of spruces. Final report.** Rothe, G.M. Mainz Univ. (Germany). Inst. fuer Allgemeine Botanik. 1991. 45p. (In German). Sponsored

by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Foerderkennzeichen BMFT 0339175H. Order Number DE95726966. Source: OSTI; NTIS (US Sales Only).

The influence of soil acidification on the carbon and nitrogen metabolism of very fine roots of spruces is investigated. All in all, the following changes in the carbohydrate metabolism of roots were observed under soil acidification and compensatory liming: Increased precipitation (neutral overhead irrigation of soil) entails a slight increase in the concentration of fructose in the root cells (+22%), while the concentration of fungal mannite decreases (-30%); exclusive liming so far had no effect worth mentioning on the investigated enzymes and metabolites. By contrast, liming with subsequent neutral overhead irrigation resulted in marked growth of roots (+44%) and increased levels of fructose (+49%) and trehalose (+35%). Compensatory liming reduced the activity of pyruvate kinase by 30%; that of mannite-1-phosphate-dehydrogenase was increased by 39% and that of NADP-mannite-dehydrogenase was reduced by 59%. The concentrations of glucose, fructose, mannite and trehalose are apparently not affected by this. (orig./UWA)

6626 (ETDE/DE-mf–95726996) **Noble metal emissions. Interim report.** Oekologische Forschung. Ende, I. (comp.). Gesellschaft fuer Strahlen- und Umweltforschung mbH Muenchen (GSF), Neuherberg (Germany). Projekttraeger Umwelt- und Klimaforschung; Forschungszentrum Juelich GmbH (Germany). Projektleitung Biologie, Oekologie, Energie. 1990. 45p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Order Number DE95726996. Source: OSTI; NTIS (US Sales Only).

Common three-way catalytic converters for the reduction of pollutant emission of motor vehicles contain platinum and rhodium as catalysts. This study goes above all into the question if under normal operating conditions platinum is emitted by mechanical abrasion or if gaseous platinum compounds are emitted with the exhaust gas. An analysis method for noble metals has to be developed which is so sensitive that the low concentrations which have an impact on the environment can be recorded. Studies on the toxic and allergic effect of noble metals have until now not been taken up within the scope of this joint research project. In the presented articles on this subject scientists of this field try based on international knowledge a first evaluation of the potential risk of 'platinum'. (orig./VT)

6627 (ETDE/DE-mf–95733464) **Influence of air pollutants and other factors of stress on phytohormone concentrations in trees. Final report. Pt. 2.** Hock, B.; Schneider, P.; Horn, K. Technische Univ. Muenchen (Germany). Lehrstuhl fuer Botanik. Apr 1990. 105p. (In German). Sponsored by Bayerisches Staatsministerium fuer Landesentwicklung und Umweltfragen, Muenchen (Germany). Contract BStLU 6495-953-25928. Order Number DE95733464. Source: OSTI; NTIS (US Sales Only).

In the framework of research described in this publication, a method for gibberellin extraction from spruce needles and an enzyme immunoassay for quantitative determination of the gibberellins GA_3 und GA_1 in the trace range were developed. HPLC permitted far-reaching clean-up of the extracts to be analyzed for the subsequent enzyme immunoassay. In addition, the separation of the gibberellins GA_3 and GA_1 was achieved. Needle analyses during exposure chamber experiments at GSF-Neuherberg revealed no significant differences between ozone-fumigated and untreated spruces and between different damage categories. Probably, this is to be attributed to the high biological variability between the individual samples. The data obtained for the site 'Wank' did not point to any association to be statistically substantiated between a tree's degree of injury or site altitude and gibberellin content. Merely analyses of symptomless and chlorotic needles corroborated a significant influence on gibberellin content, which is probably due to a seasonal fluctuation of GA_3. The available data do not permit to conclude that the gibberellins GA_3 and GA_1 have physiological relevance for early indication of forest damage. (orig./UWA)

6628 (GSF–41/93) **Air pollutants and human health. Literature documentation. As of March 1993.** Kirchner, M.; Kohmanns, B.; Reuther, M.; Rossnagel, I.; Winkler, D. GSF - Forschungszentrum fuer Umwelt und Gesundheit GmbH, Neuherberg (Germany). Projektgruppe Bayern zur Erforschung der Wirkung von Umweltschadstoffen (PBWU). Dec 1993. 272p. (In German). Order Number DE95726903. Source: OSTI; NTIS (US Sales Only); INIS.

This literature documentation for the subject 'Air pollutants and human health' lists 1180 quotations up to 1993 arranged in alphabetical order according to the first-named author. Each entry contains the ordinal number, author(s), title, source, and keywords. The appendix of the documentation contains a keyword index indicating the numbers of the relevant quotations and an authors' index permitting the retrieval of the second and next named authors via the quotation number. The quoted literature is largely present in the archives of the PBWU where it can be either consulted or borrowed. Computer-aided literature searches are performed on request. (UHE)

6629 (LA–12788-MS) **Staurosporine analysis and its pharmacokinetics in the blood of rats.** Gurley, L.R.; Umbarger, K.O.; Kim, J.M.; Bradbury, E.M.; Lehnert, B.E. Los Alamos National Lab., NM (United States). Jul 1994. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE94013857. Source: OSTI; NTIS; INIS; GPO Dep.

Staurosporine (Stsp), a protein kinase inhibitor, has been found to have a differential effect on the proliferation of normal and transformed cells in vitro. Essentially nothing is known about the distribution and pharmacokinetics of Stsp in the body. To facilitate such investigations, we have developed a High-Performance Liquid Chromatography method for measuring the levels of Stsp in blood. Stsp was measured in both plasma and RBC of rat blood. In vivo, Stsp was rapidly sequestered in some other tissue compartment, which rapidly decreased the concentration of Stsp in plasma to nondetectable levels. Using a postchromatography computerized analysis program that amplified the Stsp UV absorption peak from the HPLC. nanogram levels of Stsp were detected in vivo. Using this detection system for pharmacokinetic studies it was found that, in vivo, Stsp had a half-life of 51.6 min in plasma and 75.3 min in RBC. Tissue adsorption studies demonstrated that up to 99% of the Stsp was adsorbed by the heart and lung tissue in one pass through these organs. Extrapolation of the data from these studies suggest that 1–g Stsp injections should produce a 2- to 7-ng/ml plasma Stsp level in vivo which is in the effective range to produce G1 arrest in normal cells. The short half-life of Stsp in plasma indicates that it will be necessary to infuse Stsp at some low level following the initial bolus injection in order to maintain Stsp levels in plasma at the 1- to 10-ng/ml level for the 2- to 3-day period necessary to achieve G1 arrest in vivo.

6630 (UCRL-JC–117823) **Characterization of mutagenic activity in grain-based coffee-substitute blends and instant coffees.** Johansson, M.A.E.; Knize, M.G.; Felton, J.S.; Jagerstad, M. Lawrence Livermore National Lab., CA (United States). Jun 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9409260–1: 4. Euro-food tox meeting, No City Given (Poland), 12-16 Sep 1994). Order Number DE95003650. Source: OSTI; NTIS; GPO Dep.

Several grain-based coffee-substitute blends and instant coffees showed a mutagenic response in the Ames/Salmonella test using TA98, YG1024 and YG1O29 with metabolic activation. The beverage powders contained 150 to 500 TA98 and 1150 to 4050 YG1024 revertant colonies/gram, respectively. The mutagenic activity in the beverage powders was shown to be stable to heat and the products varied in resistance to acid nitrite treatment. Characterization of the mutagenic activity, using HPLC-and the Ames test of the collected fractions, showed the coffee-substitutes and instant coffees contain several mutagenic compounds, which are most likely aromatic amines.

5604 Other Environmental Pollutant Effects

6631 (NUREG/CR–5680-Vol.2) **The impact of environmental conditions on human performance: A critical review of the literature. Volume 2.** Echeverria, D. (Battelle Human Affairs Research Center, Seattle, WA (United States)); Barnes, V.; Bittner, A. Nuclear Regulatory Commission, Washington, DC (United States). Div. of Systems Research; Battelle Human Affairs Research Center, Seattle, WA (United States); Pacific Northwest Lab., Richland,

WA (United States). Sep 1994. 243p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). DOE Contract AC06-76RL01830. (BHARC–700/91/005-Vol.2; PNL–7675-Vol.2). Source: OSTI; NTIS; INIS; GPO.

The Battelle Human Affairs Research Centers (HARC) conducted a comprehensive review of the technical literature regarding the impact of environmental conditions on human performance applicable to nuclear power plant workers. The environmental conditions considered were vibration, noise, heat, cold, and light. Research staff identified potential human performance deficits along a continuum of increasing occupational exposure, ranging from deficits that occur at low exposures to deficits that occur at high exposures. Specific deficits were included in the review if scientists demonstrated the exposure caused an effect, using sound methodology. The levels associated with each deficit were then compared to the protection afforded by existing occupational exposure standards. Volume 2 presents several conclusions regarding the applicability of the research literature to environmental conditions in nuclear power plants. The findings presented suggest that occupational standards for vibration, noise, and heat, which were developed to protect health, are inadequate for preventing deficits in cognitive or motor performance in tasks likely to be performed in nuclear power plants. Also, there is little information in the literature on simultaneous conditions; for example, the effects of simultaneous exposure to heat and noise on cognition require more research. As many exposures in nuclear power plants will be simultaneous, this limitation should be kept in mind when using Volume 1.

6632 (SAND–93-7095) **Noise and vibration investigations of the Sandia National Laboratories Sol se Mete Aerial Cable Facility.** Matise, B.K. (New Mexico State Univ., Las Cruces, NM (United States). Physical Science Lab.); Gutman, W.M.; Cunniff, R.A.; Silver, R.J.; Stepp, W.E. Sandia National Labs., Albuquerque, NM (United States); New Mexico State Univ., Las Cruces, NM (United States). Physical Science Lab. Nov 1994. 67p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95003760. Source: OSTI; NTIS; GPO Dep.

This document is an assessment of the noise, vibration, and overpressure effects and fragmentation hazards of the operation of the Sandia National Laboratories Sol de Mete Aerial Cable Facility (ACF). Major noise sources associated with project operations and considered in this report include rocket motors, chemical explosions, 3-inch gun, 20-mm gun, vehicular traffic, and engines of electricity generators. In addition, construction equipment noise is considered. Noise exposure of ACF personnel is expressed as the equivalent sound level for the 8-hour work day, and is computed by scaling to the proper distance and combining the appropriate noise values for continuously operating equipment such as vehicles and generators. Explosions and gun firings are impulsive events, and overpressures are predicted and expressed as decibel (dB) at the control building, at other nearby facilities, at Sol se Mete. The conclusion reached in the noise analysis is that continuously operating equipment would not produce a serious noise hazard except in the immediate vicinity of the electricity generators and heavy equipment where hearing protection devices should be used. Rocket motors, guns, and detonations of less than 54 kilograms (kg) (120 lb) of explosives would not produce noise levels above the threshold for individual protection at the control building, other nearby test areas, or Sol se Mete Spring. Rare tests involving explosive weights between 54 and 454 kg (120 and 1,000 lb) could produce impulsive noise levels above 140 dB that would require evacuation or other provision for individual hearing protection at the ACF control building and at certain nearby facilities not associated with ACF. Other blast effects including overpressure, ground vibration, and fragmentation produce hazard radii that generally are small than the corresponding noise hazard radius, which is defined as the distance at which the predicted noise level drops to 140 dB.

57 HEALTH AND SAFETY

Refer also to citation(s) 5407, 6623

6633 (ETDE/DE-mf–95733278) **Safety research and safety engineering. Annual report 1992. R and D projects 1992. As of December 31, 1992.** Weg, K. (comp.). VDI-Technologiezentrum Physikalische Technologien, Duesseldorf (Germany). Jan 1993. 185p. (In German). Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Order Number DE95733278. Source: OSTI; NTIS (US Sales Only).

The research projects supported in 1992 were dedicated to risk analysis, the design of machines and plants for safe operation, (the development of methods and measures for safe hazardous materials transports), to fire protection and explosion protection, and to fire fighting and disaster control. Priority was given again to accident avoidance measures. Accident control measures intend to minimize the causes and courses of events and to investigate technical disaster control systems. (orig.)

6634 (ETDE/DE-mf–95733392) **Health research 2000. Programme of the Government of the Federal Republic of Germany.** Bundesministerium fuer Forschung und Technologie, Bonn (Germany). Referat Oeffentlichkeitsarbeit. May 1993. 144p. (In German). Order Number DE95733392. Source: OSTI; NTIS (US Sales Only).

Since 1978 the Government of the Federal Republic of Germany has promoted health research through its programme "Research and Development in the Service of Health". The newly published programme for 1993-1998, Health Research 2000, continues with the aims already pursued in previous promotion periods. Its task is to coordinate research policy and control promotion policy in crucial areas. The programme has a transsectoral design and is managed jointly by the federal ministries of research and technology and of health. Research is to focus on the principal tasks of improving the protection of public health and prevention, doing research into the causes of and methods of treatment for disease, ensuring a future development of the national health system towards greater effectivity and economic sustainability, and improving the structure of health research. This is to be achieved through an integration of clinical and fundamental research. The appendix gives an overview of how the Federal Government finances health research, of promotion and research institutions, and of the contributions by other ministries to health research and promotion programmes of the EU. (UHE)

5701 Real Accidents

Refer also to citation(s) 6125

58 GEOSCIENCES

Refer also to citation(s) 5002, 5003, 5004, 5006, 5119, 5165, 5187, 5189, 5220, 5604, 5606, 5607, 5618, 5619, 5826, 6322, 6465, 6466, 6658, 6660

6635 (CONF-9405258–, pp. 338-343) **Quality control for resistivity inversions. Part 1. Proposal of TQARI.** Haryu, T.; Nishikawa, M. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

Pertaining to the quality control for the resistivity inversions, the present paper reports the assessment of measurement data accuracy which influences the quality of analysis result. With referring actual examples of survey, the following explanation is given of the ratio of reciprocal error (RRE, index of separation due to the reciprocity between both current and voltage electrodes) as a grade assessment value of measurement error in the pole-pole electrode array, and two-dimensional resistivity survey and tomography by the pole-pole method: with a lengthening of distance between the measurement electrodes, the RRE rises generally. However, it is so influenced by the electrode earthing resistance and surface soil that its distribution becomes irregular. On the shallow subsurface, foreign conductor matter can be detected from the anomaly of RRE

distribution. However, its influence can be weakened in the process of analysis. The result of analysis with the round-trip data is more accurate than that only with the one-way data. 2 refs., 12 figs.

6636 (CONF-9405258–, pp. 455-459) **Electromagnetic physical modeling. 7.** Noguchi, K. (Waseda University, Tokyo (Japan). School of Science and Technology); Yoshioka, K.; Saito, A. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

This report presented the stabilizing method of system deconvolution process (a process in which the input function is obtained from the system output and the system function) in a model experiment. It was clarified that the stabilized deconvolution process required the spectra covering all range frequencies with relatively large magnitude and the measurement results obtained from the system response with sharp peaks. A pseudo-impulse method was proposed to response the measurement results obtained under the conditions which did not meet the above-said requirement. The solution of deconvolution process was resulted from the input function and the pseudo-impulse method. Selecting adequately the falseness in the pseudo-impulse method improves the deconvolution process results. A model experiment of the electromagnetic response of the agglomerated spheres was also conducted. The conductivity of the agglomerate was lower than the intrinsic conductivity of the material which composed the sphere. 6 refs., 14 figs., 2 tabs.

6637 (CONF-9405258–, pp. 474-478) **Magnetic susceptibility and resistivity imaging multifrequency controlled source EM technique.** Sakashita, S. (OYO Corp., Tokyo (Japan)); Shima, H.; Gasnier, S. Society of Exploration Geophysicists of Japan, Tokyo (Japan). May 1994. 539p. (In Japanese). From 90. SEGJ conference; Tokyo (Japan); 25-27 May 1994. In *Proceedings of the 90th (Spring of fiscal 1994) SEGJ (The Society of Exploration Geophysicists of Japan) Conference.* Order Number DE95722746. Source: OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan.

The following is reported about the magnetic susceptibility and resistivity imaging by EM tomography with a multi-frequency and multi-component measurement device: it was verified by model test that the linear Born approximation is appropriately used for the sequential calculation of magnetic susceptibility. Through a numerical test with a ground model where the actual distribution of magnetic susceptibility was simulated, it was confirmed that the secondary magnetic field generated in response to such magnetic susceptibility has sufficient signal strength for the natural magnetic field, and that, unless the magnetic susceptibility of ground is very low, the reverse analysis is effective in restructuring the distribution of magnetic susceptibility. Through an in-situ test with an EM tomographic measurement device which was so developed by Sakashita et al. as to obtain multi-frequency data in the region of frequencies between approx. 4Hz and approx. 17.9kHz, it was shown that the present system can measure the magnetic field with sufficient accuracy for the resistivity imaging. 7 refs., 12 figs.

6638 (ENRESA–05/94) **West Europe and Iberian Peninsula from 120.000 years ago to the present: glacial isostacy, paleogeography and paleotemperatures.** Garcin, M. (Bureau de recherches geologiques et minieres (BRGM), Servicio Geologico Natural, Departamento de Geologia (France)). No corporate text available. 1994. 86p. (In Spanish). Order Number DE95721639. Source: OSTI; NTIS.

The main objective of this paper is to describe the Occidental Europe and Iberian Peninsula during the last glacial cycle. This project has been done within the software Geoprospect, developed by BRGM.

6639 (LA-UR–94-2956) **Bursting in the near-surface boundary layer: Comparisons between realistic models and observations.** ReVelle, D.O.; Coulter, R.C. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9403185–1: American Meterorlogical Society conference on boundary layers and turbulence, Charlotte, NC (United States), 27-31 Mar 1994). Order Number DE95003714. Source: OSTI; NTIS; GPO Dep.

In this paper, the authors examine the stable, nocturnal boundary layer, bursting phenomena. Bursting (or intermittent breakdowns from turbulent to laminar flow) can occur if the critical Richardson number, Ri_c, is exceeded. During the bursting process, which occurs at irregular, chaotic intervals, periods of active turbulence (large sudden changes in u') are followed by calm periods when the air temperatures near the ground can drop rapidly. During the turbulent periods, air temperatures can also rise considerably.

6640 (NUREG/CR–6258) **The liquefaction method for assessing paleoseismicity.** Tuttle, M.P. (Columbia Univ., Palisades, NY (United States). Lamont-Doherty Earth Observatory). Nuclear Regulatory Commission, Washington, DC (United States). Div. of Engineering; Columbia Univ., Palisades, NY (United States). Lamont-Doherty Earth Observatory. Dec 1994. 39p. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Source: OSTI; NTIS; GPO; INIS.

Paleoseismicity studies expand our knowledge of seismic activity into the prehistoric period and thereby can improve our understanding of the earthquake potential of various regions. Paleoseismology is proving especially useful in eastern North America, where the recurrence interval of large earthquakes is longer than the historic record of earthquakes. Because surface traces of seismogenic faults have been difficult to identify in eastern North America, most paleoseismicity studies have employed features resulting from liquefaction. The goals of paleoliquefaction studies are to determine the recurrence intervals, magnitudes, and source areas of prehistoric earthquakes. To accomplish these goals, one must be able to identify earthquake-induced liquefaction features, determine their ages, and map their distribution. This report reviews (1) characteristics of earthquake-induced liquefaction features as well as other soft-sediment deformation structures, (2) methods for dating liquefaction features, and (3) relationships between liquefaction and the magnitude and distance of causative earthquakes. Recent studies by the author in Quebec Province, Canada and in the New Madrid seismic zone of the central United States provide the basis for this report. For additional information on the use of liquefaction features in paleoseismology see Amick et al. (1990) and Obermeier et al. (1990 and 1992).

66 PHYSICS

6641 (DOE/MI/10270–T3) **Establishing the SECME Model in the District of Columbia. Third quarter report, April 1, 1994–June 30, 1994.** Vickers, R.G. Southeastern Consortium for Minorities in Engineering, Atlanta, GA (United States). [1995]. 168p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-93MI10270. Order Number DE95004338. Source: OSTI; NTIS; GPO Dep.

This report contains a description of the planning and activities completed for the third quarter report (April - June 1994) of the 1993-1994 United States Department of Energy/Southeastern Consortium for Minorities in Engineering (SECME) grant for "Establishing the SECME Model in the District of Columbia." The program continues to have outstanding success in Establishing the SECME Model in the District of Columbia Public Schools. Exhibits of supporting documentation are included.

6642 (DOE/MI/10270–T5) **1993-1994 Final technical report for establishing the SECME Model in the District of Columbia.** Vickers, R.G. Southeastern Consortium for Minorities in Engineering, Atlanta, GA (United States). [1995]. 80p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG01-93MI10270. Order Number DE95004340. Source: OSTI; NTIS; INIS; GPO Dep.

This is the final report for a program to establish the SECME Model in the District of Columbia. This program has seen the development of a partnership between the District of Columbia Public

Schools, the University of the District of Columbia, the Department of Energy, and SECME. This partnership has demonstrated positive achievement in mathematics and science education and learning in students within the District of Columbia.

6611 Classical and Quantum Mechanics

6643 (CEA-N–2714) **Numerical resolution of the time-domain three-dimensional Maxwell equations by a conform finite element approximation. Part I: theoretical formulation.** Heintze, E. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1993. 52p. (In French). Order Number DE95611429. Source: OSTI; NTIS (US Sales Only); INIS.

The aim of this report is to present a method for solving the time-domain three-dimensional Maxwell equations. This method is based on a variational formulation and can be easily coupled with a particle solver for the Vlasov equation. The necessity to take into account complex three-dimensional geometries and to have a spatial resolution fitted to the various computation zones, leads to choose a finite element method built on tetrahedral unstructured meshes. 12 refs.

6644 (CEA-N–2715) **Numerical resolution of the time-domain three-dimensional Maxwell equations by a conform finite element approximation. Part II: numerical results.** Heintze, E. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). 1993. 58p. (In French). Order Number DE95611430. Source: OSTI; NTIS (US Sales Only); INIS.

The aim of this report is to validate the program MAX3D built up from the discretization of the formulation (FB) established in part 1. A qualitative and quantitative analysis is carried out on numerical results obtained with various test cases of which, for most of them, analytical solutions are known. 32 figs., 3 refs.

6645 (DESY–94-122) **Thermodynamic and multifractal formalism and the Bowen-series map.** Rudolph, O. (Hamburg Univ. (Germany). 2. Inst. fuer Theoretische Phy k). Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 110p. Order Number DE95725986. Source: OSTI; NTIS (US Sales Only); INIS.

In the theory of quantum chaos one studies the semiclassical behaviour of quantum mechanical systems whose corresponding classical counterparts exhibit chaos. These systems are sometimes considered as model systems in the theory of quantum chaos since they are well understood from a mathematical point of view. In this work we study the multifractal formalism for the geodesic flow on surfaces with constant negative curvature. The multifractal analysis of measures has been developed in order to characterize the scaling behaviour of measures on attractors of classical chaotic dynamical systems globally. In order to relate the multifractal formalism with quantities usually considered in the study of the geodesic flow on Riemann surfaces with constant negative curvature, it is necessary to establish the assertions of the multifractal formalism in a mathematically rigorous way. This is achieved with the help of the thermodynamic formalism for hyperbolic dynamical systems developed by Ruelle, Bowen and others. (orig.)

6646 (DESY–94-141) **Observation and superselection in quantum mechanics.** Landsman, N.P. (Hamburg Univ. (Germany). 2. Inst. fuer Theoretische Physik). Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 40p. Order Number DE95725662. Source: OSTI; NTIS (US Sales Only); INIS.

We attempt to clarify the main conceptual issues in approaches to 'objectification' or 'measurement' in quantum mechanics which are based on superselection rules. Such approaches venture to derive the emergence of classical 'reality' relative to a class of observers; those believing that the classical world exists intrinsically and absolutely are advised against reading this paper. The prototype approach (Hepp) where superselection sectors are assumed in the state space of the apparatus is shown to be untenable. Instead, one should couple system and apparatus to an environment, and postulate superselection rules for the latter. These are motivated by the locality of any observer or other (actual or virtual) monitoring system. In this way 'environmental' solutions to the measurement problem (Zeh, Zurek) become consistent and acceptable, too. Points of contact with the modal interpretation are briefly discussed. We propose a minimal value attribution to observables in theories with superselection rules, in which only central observables have properties. In particular, the eigenvalue link is dropped. This is mainly motivated by Ockham's razor. (orig.)

6612 Techniques of General Use In Physics

Refer also to citation(s) 5487, 6643, 6644

6647 (ETDE/JP-mf–95730105) **Study of very high temperature technology. 2.** National Inst. for Research in Inorganic Materials, Tsukuba (Japan). 25 Nov 1993. 52p. (In Japanese). Order Number DE95730105. Source: OSTI; NTIS; Available from National Institute for Research in Inorganic Materials, 1-1, Namiki, Tsukuba, Ibaraki, Japan.

This paper is a collection of research reports of 1993 regarding very high temperature technology published by Japan Science and Technology Agency. High-frequency thermal plasma (RF plasma) under the very high temperature generation method in the very high temperature (4000 - 10000 °C) processing technology that has recently been attracting attention of the industry have various features. The high-reactive chemical species in plasma have the same important reaction as found in diamond thin film synthesis. As an application technology, the torch is essential for generating plasma for a long time. The torch for creating the characteristic chemical species should be developed as an important factor. The measurement technologies were developed involving in these generation technologies. The main study of the very high temperature station is the development of the very high temperature generation mechanism and the application technologies. The study overview presents the development of generation system, plasma stability, measurement control, application technologies, simultaneous emission of RF plasma and UV laser, phase transfer of α-alumina in plasma, and others. Related researches are separately collected and attached to the paper as the supplement. As a result of these researches, 43 reports were presented on the paper, and 4 patents were applied in Japan. 96 refs., 82 figs., 6 tabs.

6648 (JAERI-Research–94-018) **Low-energy ion-beam deposition apparatus equipped with surface analysis system.** Ohno, Hideki (Meisei Univ., Hino, Tokyo (Japan)); Aoki, Yasushi; Nagai, Siro. Japan Atomic Energy Research Inst., Tokyo (Japan). Oct 1994. 51p. (In Japanese). Order Number DE95737272. Source: OSTI; NTIS; INIS.

A sophisticated apparatus for low energy ion beam deposition (IBD) was installed at Takasaki Radiation Chemistry Research Establishment of JAERI in March 1991. The apparatus is composed of an IBD system and a real time/in-situ surface analysis system for diagnosing deposited thin films. The IBD system provides various kinds of low energy ion down to 10 eV with current density of 10 μA/cm^2 and irradiation area of 15x15 mm^2. The surface analysis system consists of RHEED, AES, ISS and SIMS. This report describes the characteristics and the operation procedure of the apparatus together with some experimental results on depositing thin carbon films. (author).

6649 (UCRL-JC–115963) **Coplanar multiple-ring electrostatic particle-beam lenses.** Moran, M.J. Lawrence Livermore National Lab., CA (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9401108–1: 38. international symposium on electron, ion and photon beam, New Orleans, LA (United States), 7 Jan 1994). Order Number DE95003643. Source: OSTI; NTIS; INIS; GPO Dep.

Electrostatic particle-beam lenses using a concentric co-planar array of independently biased rings can be advantageous for some applications. Traditional electrostatic lenses often consist of axial series of biased rings, apertures, or tubes. The science of lens design has devoted much attention to finding axial arrangements that compensate for the substantial optical aberrations of the individual elements. Thus, as with multi-element lenses for light, a multi-element charged-particle lens can have optical behavior that is far superior to that of the individual elements. This paper discusses

the possibility that transverse multiple-concentric-ring lenses can achieve high performance, while also having advantages in terms of compactness and optical versatility.

6613 Other Aspects of Physical Science

Refer also to citation(s) 6321, 6366, 6528, 6664, 7047

6650 (DOE/ER/40272–206) **A quantum gravitational mechanism for exiting inflation.** Woodard, R.P. Florida Univ., Gainesville, FL (United States). Dept. of Physics. Aug 1994. 11p. Sponsored by USDOE, Washington, DC (United States);North Atlantic Treaty Organization, Brussels (Belgium). DOE Contract FG05-86ER40272. Grant CRG-910627. (CONF-9406248–5: Workshop on quantum infrared physics, Paris (France), Jun 1994). Order Number DE95003342. Source: OSTI; NTIS; INIS; GPO Dep.

I discuss the proposal by Nick Tsamis and myself that quantum gravity may mediate a naturally slow exit from inflation. The emphasis is on our recently completed two loop computation of the effective Hubble constant. When this result is properly checked and independently confirmed it will provide a proof that the mechanism functions in perturbation theory.

6651 (DOE/ER/40317–13) **Research in nuclear astrophysics: Stellar collapse and supernovae. Continuation progress report, December 1, 1994–November 30, 1995.** Lattimer, J.M.; Yahil, A. State Univ. of New York, Stony Brook, NY (United States). Dept. of Earth and Space Sciences. [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-87ER40317. Order Number DE95004300. Source: OSTI; NTIS; GPO Dep.

This progress report describes the nuclear astrophysics research activities in the Earth and Space Sciences Department at Stony Brook during the last year. The research focuses on three aspects of nuclear astrophysics: (1) the equation of state of hot, dense matter, (2) the origin of supernovae and neutron stars, (3) the early cooling epoch of neutron stars. Ongoing projects are first described individually, and are followed by a series of detailed reports, which summarize each project completed within the last year.

6652 (DOE/ER/40561–170) **Core-collapse supernovae and nucleosynthesis.** Haxton, W.C. Washington Univ., Seattle, WA (United States). [1994]. 15p. Sponsored by USDOE, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract FG06-90ER40561. Grant NAGW2523. (CONF-9409270–1: 3. school on astrofundamental physics, Erice (Italy), Sep 1994). Order Number DE95004357. Source: OSTI; NTIS; INIS; GPO Dep.

I discuss some of the physics that governs the collapse and explosion of a massive star, including issues such as lepton number losses in the infall stage and neutrino heating and convection following the core bounce. I review recent work on the neutrino process and the r-process, describing how the nucleosynthesis depends on the explosion mechanism. Some of the interesting possibilities for oscillations of closure mass ν_τs are discussed, along with their signatures in terrestrial detectors and in nucleosynthesis.

6653 (LA-UR–93-1428) **A study of ultra high energy radiation associated with Hercules X-1.** Biller, S.D. California Univ., Irvine, CA (United States). 1992. 273p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003508. Source: OSTI; NTIS; INIS; GPO Dep.

Data from the CYGNUS experiment has been used to examine ultra high energy (UHE) radiation associated with the X-ray binary star system Hercules X-1. A search for both pulsed, and unpulsed emission over time scales ranging from minutes to years has failed to yield a result of comparable significance to that of the previously published observation of July 24, 1986. A reassessment of this result in light of the number of hypotheses that have been examined for Hercules X-1 yields a probability estimate of 0.44% that the data is consistent with background fluctuations. If the number of independent source hypotheses is also accounted for, an overall chance probability of 1.8% is assessed for the observations of the CYGNUS experiment. The extensive air showers corresponding to the episode of July 24, 1986 contain a substantial muon content, in contradiction with traditional predictions for primary gamma-rays. No satisfactory theory has yet been put forward to explain this phenomenon. A further analysis of shower characteristics for events associated with this episode indicates a steeper radial dependence of the showerfront timing width at a chance probability level of 0.16%. This property might be explained by a model that invokes a forward-peaked and/or a deeply interacting component of the hadronic interaction in the atmosphere. The potential importance of UHE observations of Hercules X-1 is great. however the evidence is not yet compelling. Further observations will be necessary, to confirm the potential properties of associated UHE radiation.

6654 (LA-UR–94-2077) **A theory for the morphology of Laplacian growth from statistics of equivalent many-body Hamiltonian systems.** Blumenfeld, R. Los Alamos National Lab., NM (United States). [1994]. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950221–1: 3. international working conference on fractals in the natural and applied sciences, Marseille (France), 7-10 Feb 1995). Order Number DE94014473. Source: OSTI; NTIS; GPO Dep.

The evolution of two dimensional interfaces in a Laplacian field is discussed. By mapping the growing region conformally onto the unit disk, the problem is converted to the dynamics of a many-body system. This problem is shown to be Hamiltonian. An extension of the many body approach to a continuous density is discussed. The Hamiltonian structure allows introduction of surface effects as an external field. These results are used to formulate a first-principles statistical theory for the morphology of the interface using statistical mechanics for the many-body system.

6655 (LA-UR–94-3766) **CDM and Omega in the local neighborhood.** Dunn, A.M. (Univ. of Cambridge (United Kingdom). Institute of Astronomy); Laflamme, R. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940816–57: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003683. Source: OSTI; NTIS; INIS; GPO Dep.

Peebles has suggested an interesting method to trace back in time positions of galaxies called the least action method. This method applied on the Local Group galaxies seems to indicate that we live in an $\Omega \approx 0.1$ Universe. The authors have studied a cold dark matter (CDM) N-body simulation with $\Omega = 0.2$ and $H = 50 \mathrm{kms}^{-1}$/Mpc and compare trajectories traced back from the Least Action Principle and the center of mass of the particle forming CDM halos. They have shown that the agreement between these set of trajectories is at best qualitative. They have also shown that the line of sight peculiar velocities are underestimated. This discrepancy is due to orphans, CDM particles which do not end up in halos. By varying the density parameter Ω in the least action principle the authors show that using this method they would underestimate the density of the Universe by a factor of 4-5.

6656 (LA-UR–94-3937) **Resolution of the classical Hyades lithium problem.** Faulkner, J. (Univ. of California, Santa Cruz, CA (United States). Lick Observatory and Astronomy Board); Swenson, F.J. Los Alamos National Lab., NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9405264–1: Light element abundances, Elba (Italy), 23-28 May 1994). Order Number DE95003661. Source: OSTI; NTIS; GPO Dep.

For the very first time, it has recently proved possible to make a well-motivated, physically plausible, and self-consistent prediction of the Hyades G- and K-dwarf (Li,T_{eff}) relationship that matches the long-unexplained observations. The method employs the latest Iglesias &, Rogers (OPAL) interior opacities and Alexander surface opacities (whose respective values are now themselves close to empirical predictions or estimates made earlier in this Hyades project), King's recently discovered [O/Fe] enhancement (another prediction!) and utterly conventional PMS (pre-main-sequence) evolution unaided by arbitrary and ad hoc adjustable parameters. Thus, the following assumptions form a self-consistent set explaining the Hyades G- and K-dwarf (Li,T_{eff}) observations: (i) Pop. I interior opacities are now essentially correct; (ii) Pop. I surface

opacities are now essentially correct; (iii) The Hyades distance is now essentially correct; (iv) The Hyades [Fe/H] and [O/Fe] are now essentially correct, and possible changes in [Ne, Mg., or Si/Fe] are likely to have only a small effect; (v) Convective envelope overshooting is negligible; (vi) Quarreling with the above means finding at least two compensating errors in assumptions (i) through (v).

6657 (LA-UR–94-3953) **Theoretical motivation for gravitation experiments on ultra-low energy antiprotons and antihydrogen.** Nieto, M.M. Los Alamos National Lab., NM (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409264–1: Low-energy antiproton physics, Bled (Slovenia), 12-17 Sep 1994). Order Number DE95003662. Source: OSTI; NTIS; INIS; GPO Dep.

It is known that the generally accepted theories of gravity and quantum mechanics are fundamentally incompatible. Thus, when one tries to combine these theories, one must beware of physical pitfalls. Modern theories of quantum gravity are trying to overcome these problems. Any ideas must confront the present agreement with general relativity, but yet be free to wonder about not understood phenomena, such as the dark matter problem. This all has led some "intrepid" theorists to consider a new gravitational regime, that of antimatter. Even more "daring" experimentalists are attempting, or considering attempting, the measurement of the gravitational force on antimatter, including low-energy antiprotons and, perhaps most enticing, antihydrogen.

6658 (SAND–93-2557C) **Axial focusing of impact energy in the earth's interior: A possible link to flood basalts and hotspots.** Boslough, M.B.; Chael, E.P.; Trucano, T.G.; Crawford, D.A.; Campbell, D.L. Sandia National Labs., Albuquerque, NM (United States). [1994]. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-940285–1: New developments regarding the KT event and other catastrophes in earth history, Houston, TX (United States), 9-12 Feb 1994). Order Number DE95003357. Source: OSTI; NTIS; GPO Dep.

We present the results of shock physics and seismological computational simulations that show how energy from a large impact can be coupled to the interior of the Earth. The radially-diverging shock wave generated by the impact decays to linearly elastic seismic waves. These waves reconverge (minus attenuation) along the axis of symmetry between the impact and its antipode. The locations that experience the most strain cycles with the largest amplitudes will dissipate the most energy and have the largest increases in temperature (for a given attenuation efficiency). We have shown that the locus of maximum energy deposition in the mantle lies along the impact axis. Moreover, the most intense focusing is within the asthenosphere at the antipode, within the range of depths where mechanical energy is most readily converted to heat. We propose that if large impacts on the Earth leave geological evidence anywhere other than the impact site itself, it will be at the antipode. We suggest that the most likely result of the focusing for a sufficiently large impact, consistent with features observed in the geological record, would be a flood basalt eruption at the antipode followed by hotspot volcanism. A direct prediction of this model would be the existence of undiscovered impact structures whose reconstructed locations would be antipodal to flood basalt provinces. One such structure would be in the Indian Ocean, associated with the Columbia River Basalts and Yellowstone; another would be a second K/T impact structure in the Pacific Ocean, associated with the Deccan Traps and Reunion.

6659 (SAND–94-1186C) **High gain GaAs Photoconductive Semiconductor Switches (PCSS): Device lifetime, high current testing, optical pulse generators.** Zutavern, F.J.; Loubriel, G.M.; Helgeson, W.D.; O'Malley, M.W.; Gallegos, R.R.; Hjalmarson, H.P.; Baca, A.G.; Plut, T.A. Sandia National Labs., Albuquerque, NM (United States). [1995]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-941006–3: Annual conference of the Optical Society of America and exhibit, Boston, MA (United States), 30 Oct - 4 nov 1994). Order Number DE95003354. Source: OSTI; NTIS; GPO Dep.

This paper presents results from three areas of GaAs PCSS research and development: device lifetime, high current switching, and PCSS-driven laser diode arrays (LDA). The authors have performed device lifetime tests on both lateral and vertical switches as a function of current amplitude, pulse width, and charging time. At present, their longest-lived switch reached 4×10^6 pulses. Scanning electron microscope (SEM) images show damage near the contacts even after only 5 pulses. They are presently searching for the threshold at which no damage is evident after a single shot. In high current tests, they have reached 5.2 kA at 4.2 kV. This was achieved using twenty fiber-optic coupled lasers to distribute current filaments over a 5 mm wide PCSS. Current waveforms and images of the current filaments as a function of current amplitude will be presented. The lasers used to trigger the high current PCSS were driven with a miniature PCSS. Low inductance, high speed GaAs PCSS are very effective as short pulse laser diode array drivers. Some types of arrays gain switch, producing a compressed optical pulse which is only 75 ps wide. Results from tests with a variety of laser diode arrays will be presented.

6660 (SAND–94-1816C) **Axial focusing of energy from a hypervelocity impact on earth.** Boslough, M.B.; Chael, E.P.; Trucano, T.G.; Crawford, D.A. Sandia National Labs., Albuquerque, NM (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9410131–11: 1994 hypervelocity impact symposium, Santa Fe, NM (United States), 16-20 Oct 1994). Order Number DE95003347. Source: OSTI; NTIS; INIS; GPO Dep.

We have performed computational simulations to determine how energy from a large hypervelocity impact on the Earth's surface would couple to its interior. Because of the first-order axial symmetry of both the impact energy source and the stress-wave velocity structure of the Earth, a disproportionate amount of energy is dissipated along the axis defined by the impact point and its antipode (point opposite the impact). For a symmetric and homogeneous Earth model, all the impact energy that is radiated as seismic waves into the Earth at a given takeoff angle (ray parameter), independent of azimuthal direction, is refocused (minus attenuation) on the axis of symmetry, regardless of the number of reflections and refractions it has experienced. Material on or near the axis of symmetry experiences more strain cycles with much greater amplitude than elsewhere, and therefore experiences more irreversible heating. The focusing is most intense in the upper mantle, within the asthenosphere, where seismic energy is most effectively converted to heat. For a sufficiently energetic impact, this mechanism might generate enough local heating to create an isostatic instability leading to uplift, possibly resulting in rifting, volcanism, or other rearrangement of the interior dynamics of the planet. These simulations demonstrate how hypervelocity impact energy can be transported to the Earth's interior, supporting the possibility of a causal link between large impacts on Earth and major internally-driven geophysical processes.

6661 (SLAC-PUB–6671) **Crossing symmetry is incompatible with general relativity.** Noyes, H.P. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Dec 1994. 2p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9407129–3: 7. Marcel Grossman meeting on general relativity, Stanford, CA (United States), 24-29 Jul 1994). Order Number DE95004287. Source: OSTI; NTIS; INIS; GPO Dep.

Short communication. GENERAL RELATIVITY THEORY/ symmetry breaking; ANTIMATTER; GRAVITATION

6620 Physics of Elementary Particles and Fields

6662 (DOE/ER–0614P) **High energy physics advisory panel's subpanel on vision for the future of high-energy physics.** USDOE Office of Energy Research, Washington, DC (United States). High Energy Physics Div. May 1994. 157p. Sponsored by USDOE, Washington, DC (United States). Order Number DE94013641. Source: OSTI; NTIS; INIS; GPO Dep.

This report was requested by the Secretary of Energy to (1) define a long-term program for pursuing the most important high-energy physics goals since the termination of the Superconducting Super Collider (SSC) project, (2) assess the current US high-energy physics program, and (3) make recommendations regarding

the future of the field. Subjects on which recommendations were sought and which the report addresses were: high-energy physics funding priorities; facilitating international collaboration for future construction of large high-energy physics facilities; optimizing uses of the investment made in the SSC; how to encourage displaced scientists and engineers to remain in high-energy physics and to attract young scientists to enter the field in the future. The report includes a description of the state of high-energy physics research in the context of history, a summary of the SSC project, and documentation of the report's own origins and development.

6663 (DOE/ER/02504–341) **High Energy Accelerator and Colliding Beam User Group. Progress report, May 1, 1980–March 31, 1981.** Snow, G.A. Maryland Univ., College Park, MD (United States). Dec 1980. 42p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-76ER02504. Order Number DE94014071. Source: OSTI; NTIS; GPO Dep.

The major activities of the High Energy Physics Group at the University of Maryland during the current contract period have been: analysis of e^+e^- events from the PLUTO detector at PETRA, design and construction of modifications to PLUTO for 2γ physics, analyses of $\nu_\mu D_2$ bubble chamber pictures from Fermilab, completion of the $\nu_\mu e$ elastic scattering experiment at Fermilab, development and demonstration of an ultra cold neutron source produced by Doppler shifting, testing of equipment for the hadron jet experiment at Fermilab that is about to begin, and planning for large projects in the future.

6664 (DOE/ER/40103–T6) **Final technical report: DOE-High Energy Physics contract with the University of Hawaii.** Hawaii Univ., Honolulu, HI (United States). [1995]. 46p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-83ER40103. Order Number DE95004214. Source: OSTI; NTIS; INIS; GPO Dep.

This report is divided into two sections: (1) experimental program; and (2) theoretical program. In each case the report includes a highly condensed summary of the major developments on various Hawaii projects. The various experimental programs in which Hawaii played a significant role during this period are: (1) neutrino bubble chamber experiments; (2) electron-positron colliding beams; (3) development of silicon particle-position detectors for HEP; (4) proton decay search; (5) high energy gamma-ray astronomy; and (6) DUMAND project. The theoretical programs are: (1) research in neutrino physics; (2) supernova neutrinos; (3) solar neutrinos; (4) atmospheric neutrinos; (5) searching for supersymmetry; (6) Higgs boson searches; (7) simulation of supersymmetry; (8) signals of R-parity violation; (9) leptoquarks, stable heavy particles and other exotica; (10) CP non conservation; (11) neutron electron dipole moment; (12) heavy quark physics; and (13) hadron spectroscopy.

6665 (LBL–91-Rev.-8/94) **Current experiments in elementary particle physics. Revision.** Galic, H. (Stanford Linear Accelerator Center, Menlo Park, CA (United States)); Armstrong, F.E.; von Przewoski, B. Lawrence Berkeley Lab., CA (United States); Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1994. 174p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00098 ; AC03-76SF00515. Order Number DE95003797. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains summaries of 568 current and recent experiments in elementary particle physics. Experiments that finished taking data before 1988 are excluded. Included are experiments at BEPC (Beijing), BNL, CEBAF, CERN, CESR, DESY, FNAL, INS (Tokyo), ITEP (Moscow), IUCF (Bloomington), KEK, LAMPF, Novosibirsk, PNPI (St. Petersburg), PSI, Saclay, Serpukhov, SLAC, and TRIUMF, and also several underground and underwater experiments. Instructions are given for remote searching of the computer database (maintained under the SLAC/SPIRES system) that contains the summaries.

6621 General Theory of Particles and Fields

Refer also to citation(s) 6661, 6708

6666 (CEA-N–2722) **Spin and intrinsic angular momentum; application to the electromagnetic field.** Paillere, P. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). May 1993. 55p. (In French). Order Number DE95611462. Source: OSTI; NTIS (US Sales Only); INIS.

Within the framework of the field theory governed by a Lagrangian, function of the tensor quantities and their covariant first derivatives, and starting with the third order intrinsic angular momentum tensor obtained from a variational principle, the intrinsic angular momentum vector of the electromagnetic field in vacuum is determined. This expression leads to spin matrices for the electromagnetic field, with unity as eigenvalue, thus allowing to bridge the gap between continuous physics and quantum physics. 6 refs.

6667 (DESY–94-135) **Renormalization group flow in a general gauge theory.** Skarke, H. (Hamburg Univ. (Germany). 1. Inst. fuer Theoretische Physik). Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 13p. (ITP-UH–10/94; HEP-TH–9407086). Order Number DE95725956. Source: OSTI; NTIS (US Sales Only); INIS.

The renormalization group flow in a general renormalizable gauge theory with a simple gauge group in 3+1 dimensions is analyzed. The flow of the ratios of the Yukawa couplings and the gauge coupling is described in terms of a bounded potential, which makes it possible to draw a number of non-trivial conclusions concerning the asymptotic structure of the theory. A classification of possible flow patterns is given. (orig.)

6668 (DESY–94-150) **Spectrum of the Dirac operator and multigrid algorithm with dynamical staggered fermions.** Kalkreuter, T. (Kaiserslautern Univ. (Germany). Fachbereich Physik). Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 21p. Sponsored by Deutsche Forschungsgemeinschaft, Bonn (Germany). (HUB-IEP–94/12; KL-TH–19/94). Order Number DE95725566. Source: OSTI; NTIS (US Sales Only); INIS.

Complete spectra of the staggered Dirac operator D are determined in quenched four-dimensional SU(2) gauge fields, and also in the presence of dynamical fermions. Periodic as well as antiperiodic boundary conditions are used. An attempt is made to relate the performance of multigrid (MG) and conjugate gradient (CG) algorithms for propagators with the distribution of the eigenvalues of D. The convergence of the CG algorithm is determined only by the condition number k and by the lattice size. Since k's do not vary signigicantly when quarks become dynamic, CG convergence in unquenched fields can be predicted from quenched simulations. On the other hand, MG convergence is not affected by k but depends on the spectrum in a more subtle way. (orig.)

6669 (DESY–94-157) **Metaplectic spinor fields and global anomalies.** Reuter, M. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Sep 1994. 29p. Order Number DE95731949. Source: OSTI; NTIS (US Sales Only); INIS.

We investigate spinor fields on phase-spaces. Under local frame-rotations they transform according to the (infinite-dimensional, unitary) metaplectic representation of Sp(2N) which plays a role analogous to the Lorentz group. We introduce a one-dimensional nonlinear sigma-model whose target space is the phase-space under consideration. The global anomalies of this model are analyzed, and it is shown that its fermionic partition function is anomalous exactly if the underlying phase-space is not a spin-manifold, i.e., if metaplectic spinor fields cannot be introduced consistently. The sigma-model is constructed by giving a path-integral representation to the Lie-transport of spinors along the hamiltonian flow. (orig.)

6670 (INS–1038) **Non-critical string field theory with non-orientable string interactions.** Watabiki, Yoshiyuki. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jun 1994. 16p. Order Number DE95737160. Source: OSTI; NTIS; INIS.

We study the non-critical string field theory with non-orientable string interactions by using the transfer matrix formalism in the dynamical triangulation. For any value of c (total central charge of matter), we have constructed the non-orientable string field theory at the discrete level. Two coupling constants G and G' which satisfy the relation $(G')^3=GG'$ are introduced, where G counts the number of untwisted handles of the world-sheet while G' counts

the number of cross-caps. In the case of the non-critical string theory which correspond to multicritical one matrix models (including c=0 case), we have succeeded in taking the continuum limit, and then have obtained the continuous string field theory. (author).

6671 (INS–1042) **Quantization of a relativistic particle on the SL(2.R) manifold based on Hamiltonian reduction.** Jorjadze, G. (AN Gruzinskoj SSR, Tbilisi (Georgia). Tbilisskij Matematicheskij Inst.); O'Raifeartaigh, L.; Tsutsui, I. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1994. 13p. Order Number DE95737163. Source: OSTI; NTIS; INIS.

A quantum theory is constructed for the system of a relativistic particle with mass m moving freely on the SL(2.R) group manifold. Applied to the cotangent bundle of SL(2.R). the method of Hamiltonian reduction allows us to split the reduced system into two coadjoint orbits of the group. We find that the Hilbert space consists of states given by the discrete series of the unitary irreducible representations of SL(2.R). and with a positive-definite, discrete spectrum. (author).

6672 (INS–1043) **On the string equation at c=1.** Nakatsu, Toshio. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1994. 18p. Order Number DE95737161. Source: OSTI; NTIS; INIS.

The analogue of the string equation which specifies the partition function of c=1 string with a compactification radius β is an element of $Z_{\geq 1}$ is described in the framework of Toda lattice hierarchy. (author).

6673 (INS–1047) **The topological string associated with a simple singularity of type D.** Nakatsu, Toshio. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Aug 1994. 15p. Order Number DE95737229. Source: OSTI; NTIS; INIS.

The partition function of D_{N+1} topological string, the coupled system of topological gravity and D_{N+1} topological minimal matter, is proposed in the framework of KP hierarchy. It is specified by the elements of GL(∞) which constitute the deformed family from the A_{2N-1} topological string. Its dispersionless limit is investigated from the view of both dispersionless KP hierarchy and singularity theory. In particular the free energy restricted on the small phase space coincides with that for the topological Landau-Ginzburg model of type D_{N+1}. (author).

6674 (INS–1048) **Global aspects of the WZNW reduction to Toda theories.** Tsutsui, I.; Feher, L. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Aug 1994. 23p. Order Number DE95737230. Source: OSTI; NTIS; INIS.

It is well-known that the Toda Theories can be obtained by reduction from the Wess-Zumino-Novikov-Witten (WZNW) model, but it is less known that this WZNW → Toda reduction is 'incomplete'. The reason for this incompleteness being that the Gauss decomposition used to define the Toda fields from the WZNW field is valid locally but not globally over the WZNW group manifold, which implies that actually the reduced system is not just the Toda theory but has much richer structures. In this note we furnish a framework which allows us to study the reduced system globally, and thereby present some preliminary results on the global aspects. For simplicity, we analyze primarily 0+1 dimensional toy models for G=SL(n,R), but we also discuss the 1+1 dimensional model for G=SL(2,R) which corresponds to the WZNW → Liouville reduction. (author).

6675 (LA-UR–94-3816) **Φ^4 kinks: Statistical mechanics.** Habib, S. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409241–4: NEEDS '94, Los Alamos, NM (United States), 12-16 Sep 1994). Order Number DE95003693. Source: OSTI; NTIS; GPO Dep.

Some recent investigations of the thermal equilibrium properties of kinks in a 1+1-dimensional, classical ϕ^4 field theory are reviewed. The distribution function, kink density, correlation function, and certain thermodynamic quantities were studied both theoretically and via large scale simulations. A simple double Gaussian variational approach within the transfer operator formalism was shown to give good results in the intermediate temperature range where the dilute gas theory is known to fail.

6676 (LA-UR–94-3852) **Disorder-induced breakdown of soliton and polaron particles.** Bishop, A.R.; Cai, D.; Gronbech-Jensen, N.; Salkola, M.I. Los Alamos National Lab., NM (United States). [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409182–2: Fluctuation phenomena: disorder and nonlinearity conference, Madrid (Spain), 26-30 Sep 1994). Order Number DE95003694. Source: OSTI; NTIS; GPO Dep.

Using examples of the perturbed (1+1) dimensional sine-Gordon, the continuous and discrete nonlinear Schroedinger systems, and a three-site quantum polaron problem, the authors briefly review some phenomena related to the fascinating interplays between nonlinearity, disorder, noise, nonadiabaticity, and lattice discreteness. The concept of competing length-scales and time-scales is emphasized as they pertain to the common concept of solitons and polarons behaving as "particles."

6677 (UM-P–93/62) **A new formulation of quantum field theory on S_4.** Harris, B.A.; Joshi, G.C. Melbourne Univ., Parkville, VIC (Australia). School of Physics. [1993]. 42p. (UM-P–91/50; UM-P–92/72.). Order Number DE95607098. Source: OSTI; NTIS (US Sales Only); INIS.

Recent developments in quantum gravity suggest that wormholes may influence the observed values of the constants of nature. The Euclidean formulation of quantum gravity predicts that wormholes induce a probability distribution in the space of possible fundamentals constants. In particular, the effective action on a large spherical space may lead to the vanishing of the cosmological constant and possibly determine the values of other constants of nature. The ability to perform calculations involving interacting quantum fields, particularly non-Abelian models, on a four-sphere is vital if one is to investigate this possibility. In this paper, a new formulation of field theory on a four-sphere is presented using the angular momentum space representation of SO(5). A review of field theory on a sphere is given and then show how a matrix element prescription in angular momentum space and a new summation technique based on the complex l-plane, overcome previous limitations in calculation techniques. The standard one-loop graphs of QED are given as examples. 13 refs., 3 figs.

6622 Specific Theories and Interaction Models; Particle Systematics

Refer also to citation(s) 6453, 6454, 6657, 6710, 6714, 6746, 6749, 6758, 6765, 6771, 6776, 6778, 6791, 6792, 6795

6678 (BNL–48922-Rev.4/94) **PHENIX CDR update: An experiment to be performed at the Brookhaven National Laboratory relativistic heavy ion collider. Revision.** Brookhaven National Lab., Upton, NY (United States). Nov 1994. 297p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95003026. Source: OSTI; NTIS; INIS; GPO Dep.

The PHENIX Conceptual Design Report Update (CDR Update) is intended for use together with the Conceptual Design Report (CDR). The CDR Update is a companion document to the CDR, and it describes the collaboration's progress since the CDR was submitted in January 1993. Therefore, this document concentrates on changes, refinements, and decisions that have been made over the past year. These documents together define the baseline PHENIX detector that the collaboration intends to build for operation at RHIC startup. In this chapter the current status of the detector and its motivation are briefly described. In Chapters 2 and 3 the detector and the physics performance are more fully developed. In Chapters 4 through 13 the details of the present design status, the technology choices, and the construction costs and schedules are presented. The physics goals of PHENIX collaboration have remained exactly as they were described in the CDR. Primary among these is the detection of a new phase of matter, the quark-gluon plasma (QGP), and the measurement of its properties. The PHENIX experiment will measure many of the best potential QGP signatures to see if any or all of these physics variables show anomalies simultaneously due to the formation of the QGP.

6679 (DESY–94-126) **Compact lattice QED with staggered fermions and chiral symmetry breaking.** Hoferichter, A. (Humboldt-Universitaet, Berlin (Germany). Sektion 3 - Fachbereich Physik); Mitrjushkin, V.K.; Mueller-Preussker, M. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 14p. Sponsored by Deutsche Forschungsgemeinschaft, Bonn (Germany). Grant DFG Mu 932/1-2. (HU-Berlin-IEP–94/11; HEP-LAT–9407009). Order Number DE95725955. Source: OSTI; NTIS (US Sales Only); INIS.

Different formulations of the 4d compact lattice QED with staggered fermions (standard Wilson and modified by suppression of lattice artifacts) are investigated by Monte Carlo simulations within the quenched approximation. We show that after suppressing lattice artifacts the system undergoes a phase transition from the Coulomb phase into a presumably weakly chirally broken phase only at (unphysical) negative β-values. (orig.)

6680 (DESY–94-129) **Transition from $SU(2)_L xSU(2)_R xU(1)_{B-L}$ representation to $SU(2)_L xU(1)_Y$ by q-deformation and the corresponding classical breaking term of chiral U(2).** Boenisch, R. (Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). inst. fuer Hochenergiephysik). Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Jul 1994. 15p. (HEP-TH–9407162). Order Number DE95725965. Source: OSTI; NTIS (US Sales Only); INIS.

The minimal Standard Model exhibits a nontrivial chiral U(2) symmetry if the VEV and the hypercharge splitting $\Delta=(y_R{}^u-y_R{}^d)/2$ of right-handed leptons (quarks) in a family vanish and $Q=T_0+Y$ independently in each helicity sector. As a generalization, we start with $SU(2)_L xSU(2)_R xU(1)_{(B-L)}$ and introduce Δ as a continuous parameter which is a measure of explicit symmetry breakdown. Values $0\leq\Delta\leq 1/2$ take the neutral generator of the isospin-1/2 representation to the singlet representation, i.e. 'deformes' the LR representation into the minimal Standard one. The corresponding classical O(3)-breaking term is a magnetic field perpendicular to the x_3-axis. A simple mapping on the fundamental Drinfeld-Jimbo q-deformed SU(2) representation is given. (orig.)

6681 (DESY–94-134) **Reggeon interactions in perturbative QCD.** Kirschner, R. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Aug 1994. 15p. Order Number DE95725966. Source: OSTI; NTIS (US Sales Only); INIS.

We study the pairwise interaction of reggeized gluons and quarks in the Regge limit of perturbative QCD. The interactions are represented as integral kernels in the transverse momentum space and as operators in the impact parameter space. We observe conformal symmetry and holomorphic factorization in all cases. (orig.)

6682 (DESY–94-142) **The geometric Schwinger Model on the Torus II.** Joos, H. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany)); Azakov, S.I. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 27p. Order Number DE95725661. Source: OSTI; NTIS (US Sales Only); INIS.

The geometric Schwinger Model (gSM) is the theory of a U(1)-gauge field in two dimensions coupled to a massless Dirac Kaehler field. It is equivalent to a Schwinger model with Dirac fields $\Phi_a{}^b(x)$ carrying iso-spin 1/2. We consider this model on the Euclidean space time of a torus. In Part I we discussed in detail the zero mode structure of this model. The main aim of this Part is the calculation of the correlation functions of currents and densities. Since it turned out that the gSM illustrates the generally interesting structure of anomalous chiral symmetry breaking in a very transparent manner, we present our results in the more familiar language of Dirac fields. In the introduction to the first part of our investigations we mentioned as motivation for the study of the gSM on the torus the possibility of a systematic lattice approximation of this model. In the meanwhile this project was realized to a large extend. Here we give the details of the discussion of the different quantities in the continuum to which we applied the lattice approximation. For these we formulate the 'geometric' description by differential forms of quantities which we consider interesting in this context. (orig.)

6683 (DESY–94-151) **Compact lattice QED with Wilson fermions.** Hoferichter, A. (Humboldt-Universitaet, Berlin (Germany). Sektion 3 - Fachbereich Physik); Mitrjushkin, V.K.; Mueller-Preussker, M.; Neuhaus, T.; Stueben, H. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 32p. Sponsored by Deutsche Forschungsgemeinschaft, Bonn (Germany). (HU-Berlin-IEP–94/13). Order Number DE95725564. Source: OSTI; NTIS (US Sales Only); INIS.

We study the phase structure and the chiral limit of 4d compact lattice QED with Wilson fermions (both dynamical and quenched). We use the standard Wilson gauge action and also a modified one suppressing lattice artifacts. Different techniques and observables to locate the chiral limit are discussed. (orig.)

6684 (DOE/ER/40448–T1) **Theoretical aspects of electroweak and other interactions in medium energy nuclear physics. Interim progress report.** Mukhopadhyay, N.C. Rensselaer Polytechnic Inst., Troy, NY (United States). Dept. of Physics. 5 Dec 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-88ER40448. Order Number DE95004341. Source: OSTI; NTIS; INIS; GPO Dep.

Significant progress has been made in the current project year in the development of chiral soliton model and its applications to the electroweak structure of the nucleon and the Delta (1232) resonance. Further progress also has been made in the application of the perturbative QCD (pQCD) and the study of physics beyond the standard model. The postdoctoral associate and the graduate student working towards his Ph.D. degree have both made good progress. The review panel of the DOE has rated this program as a "strong, high priority" one. A total of fifteen research communications – eight journal papers and, conference reports and seven other communications – have been made during the project year so far. The principal investigator is a member of the Physics Advisory Committee of two nuclear accelerator facilities.

6685 (DOE/ER/40561–168) **Neutrino oscillations from discrete non-Abelian family symmetries.** Schmaltz, M. Washington Univ., Seattle, WA (United States). Inst. for Nuclear Theory. Nov 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-90ER40561. Order Number DE95004355. Source: OSTI; NTIS; INIS; GPO Dep.

The author discusses a SUSY-GUT model with a non-Abelian discrete family symmetry that explains the observed hierarchical pattern of quark and lepton masses. This SO(10) $\times$ $\Delta(75)$ model predicts modified quadratic seesaw neutrino masses and mixing angles which are interesting for three reasons: (1) they offer a solution to the solar neutrino problem, (2) the tau neutrino has the right mass for a cosmologically interesting hot dark matter candidate, and (3) they suggest a positive result for the $\nu_\mu \rightarrow \nu_\tau$ oscillation searches by the CHORUS and NOMAD collaborations. However, the model shares some problems with many other predictive GUT models of quark and lepton masses. Well-known and once successful mass and angle relations, such as the SU(5) relation $\lambda_b{}^{GUT} = \lambda_l{}^{GUT}$, are found to be in conflict with the current experimental status. Attempts to correct these relations seem to lead to rather contrived models.

6686 (INS–1059) **Pion-nucleon and kaon-nucleon scattering lengths in QCD sum rules.** Kondo, Y.; Morimatsu, O.; Nishino, Y. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Sep 1994. 15p. Order Number DE95737278. Source: OSTI; NTIS; INIS.

The pion-nucleon and kaon-nucleon scattering lengths are studied in the QCD sum rule. We show that the leading and next-to-leading order terms of OPE give rise to the Tomozawa-Weinberg and sigma terms, respectively. We also show that in the kaon-nucleon system the $\Lambda(1405)$ contribution has to be subtracted from the OPE side in order to obtain the scattering length. The odd components of the T-matrices are in agreement with the experimental values not only in the pion-nucleon channel but also in the kaon-nucleon channel after the $\Lambda(1405)$ contribution subtracted. The even components disagree with the experimental values in the pion-nucleon channel, which is similar to the situation in the PCAC-plus-current-algebra approach at the Weinberg point. We speculate

that this discrepancy should be explained by the continuum contribution in the spectral function above the pion-nucleon threshold. (author).

6687 (LBL–34831, pp. 1-39) **Relativistic heavy ion collisions: "Re-creating" the early universe in the laboratory.** Mueller, B. (Duke Univ., Durham, NC (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract FG05-90ER40592. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Central nuclear collisions at energies of many GeV/nucleon may provide for conditions similar to those in the early universe during the first few microseconds, where the transition from highly excited hadronic matter into quark matter or quark-gluon plasma can be probed. Here, the author reviews the current understanding of the physical properties of a quark-gluon plasma and reviews ideas about the nature of, and signals for, the deconfinement transition. The author also discusses recent progress in the treatment of the formation of a thermalized state at the QCD parton level.

6688 (LBL–34831, pp. 73-85) **Gluon multiplication in high energy heavy ion collisions.** Xiong, Li (State Univ. of New York, Stony Brook, NY (United States)); Shuryak, E. Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract FG02-88ER40388. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Hot gluons are the dominant components of the QCD plasma to be formed in future high energy heavy ion experiments. In this work, the authors study the elementary processes in the plasma medium for gluon multiplication based on all orders of the three-diagrams in perturbative QCD. When applying to the chemical equilibration in the expanding system, they found that the gluons reach chemical equilibrium well within its plasma phase. The inclusion of all the next-to-leading order processes makes the equilibration considerably faster than the simply gg $\leftrightarrow$ ggg one considered previously.

6689 (LBL–34831, pp. 87-98) **Time evolution of the quark-gluon plasma.** Cooper, F. (Los Alamos National Lab., NM (United States)); Kluger, Y.; Dawson, J.; Shepard, H. Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors derive the renormalized time evolution equations for the production and time evolution of an SU(2) Yang Mills Plasma from a neutral semi-classical Yang-Mills Field. They show that in a background Feynman gauge that the ghost degrees of freedom cancel the unphysical modes of the Yang-Mills field in the induced current that controls the back-reaction on the initial semi-classical neutral field. This model is a prototype for the production of the non-abelian gluon plasma following a Relativistic Heavy Ion collision. The non-abelian nature determines the renormalization properties of the back-reaction equation and displays the asymptotic freedom property of the Yang-Mills field.

6690 (LBL–34831, pp. 99-111) **Transport equations embodying particle production and back-reaction.** Eisenberg, J.M. (TRIUMF, Vancouver (Canada)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

A brief summary is presented of studies of systems in which pairs are produced in a strong electric field, are accelerated by it, and then react back on it through the counter-field produced by their current. This picture has often been used in phenomenological treatments of effects that may arise in the quark-gluon plasma (QGP). Here the field formulation of the problem is sketched for charged bosons, requiring a renormalization program which is outlined very briefly. A phenomenological transport equation is presented that embodies physics essentially identical to that of the field formulation. Numerical results are shown to substantiate this claim, and the corresponding physical behavior of the system is discussed. Extensions are noted to the fermion case, to the formulation in terms of boost-invariant variables (needed for the QGP), and to the formal derivation of the transport equations. The presentation here stresses the development of a practicable calculational scheme for eventual use in studies of the QGP. In that spirit, work in progress on the study of more realistic conditions-namely, non-classical (electric) fields, non-Abelian fields, and spatial dependence is noted.

6691 (LBL–34831, pp. 113-124) **QCD transport theory.** Heinz, U. (Univ. of California, Santa Barbara, CA (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. Grant PHY89-04035. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The author reviews recent progress in the development of a transport theory for quarks and gluons and in the understanding of the transport properties of a quark-gluon plasma.

6692 (LBL–34831, pp. 125-136) **Transport properties of quark and gluon plasmas.** Heiselberg, H. (Lawrence Berkeley Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract AC03-76SF00098. Grant PHY89-21025; Grant PHY91-00283; Grant NAGW-1583. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The kinetic properties of relativistic quark-gluon and electron-photon plasmas are described in the weak coupling limit. The troublesome Rutherford divergence at small scattering angles is screened by Debye screening for the longitudinal or electric part of the interactions. The transverse or magnetic part of the interactions is effectively screened by Landau damping of the virtual photons and gluons transferred in the QED and QCD interactions respectively. Including screening a number of transport coefficients for QCD and QED plasmas can be calculated to leading order in the interaction strength, including rates of momentum and thermal relaxation, electrical conductivity, viscosities, flavor and spin diffusion of both high temperature and degenerate plasmas. Damping of quarks and gluons as well as color diffusion in quark-gluon plasmas is, however, shown not to be sufficiently screened and the rates depends on an infrared cut-off of order the "magnetic mass," $m_{mag} \sim g^2T$.

6693 (LBL–34831, pp. 137-150) **Color collective effects at the early stage of ultrarelativistic heavy-ion collisions.** Mrowczynski, S. (Soltan Institute for Nuclear Studies, Warsaw (Poland)). Lawrence Berkeley Lab., CA (United States). [1993]. Grant 20436-91-01. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Hard and semihard processes lead to a copious production of partons at the early stage of ultrarelativistic heavy-ion collisions. Since the parton momentum distribution is strongly anisotropic the system can be unstable with respect to the specific plasma modes. The conditions of instability are found and the characteristic time of its development is estimated. Then, the screening of the static chromoelectric field in the nonequilibrium plasma is studied. Importance of the two phenomena for heavy-ion collisions at RHIC and LHC is critically discussed.

6694 (LBL–34831, pp. 151-158) **Collective non-abelian phenomena in quark gluon plasma.** Parikh, J.C. (Physical Research Lab., Ahmedabad (India)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Some specific aspects of production and evolution of quark gluon plasma are discussed. For A - A collisions, $q\bar{q}$ pair production in the color flux tube model is determined, in the presence of an oscillating color field. Thermalization of the plasma due to its

chaotic behavior is examined in a (1+1)-dimension particle simulation code.

6695 (LBL–34831, pp. 159-170) **Color diffusion in QCD transport theory.** Selikhov, A.V. (Columbia Univ., New York, NY (United States)); Gyulassy, M. Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract FG02-93ER40764. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Color diffusion is shown to be an important dissipative property of quark-gluon plasmas with the characteristic color relaxation time scale, $t_c \sim (3\alpha_s T \log (m_E/m_M))^{-1}$, showing its sensitivity to the ratio of the static color electric and magnetic screening masses. Fokker-Planck equations are derived for QCD Wigner distributions taking into account quantum color dynamics. These equations show that the anomalously small color relaxation time leads to a small color conductivity and to strong damping of collective color modes.

6696 (LBL–34831, pp. 171-182) **Parton interaction rates and limits of perturbative QCD.** Thoma, M.H. (Universitaet Giessen (Germany)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The relevance of parton interaction rates for observables of a quark-gluon plasma and for testing field theoretical methods is exhibited. Using the Braaten-Pisarski method the interaction rate as well as the transport rate beyond the leading logarithm approximation are estimated. Limits on the validity of perturbative QCD for relativistic heavy ion collisions are discussed.

6697 (LBL–34831, pp. 183-196) **Influence of the Landau-Pomeranchuk effect on lepton-pair production.** Cleymans, J. (Univ. of Cape Town, Rondebosch (South Africa)); Goloviznin, V.V.; Redlich, K. Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

An estimate is made of the Landau-Pomeranchuk effect on the production of dileptons in a hadronic gas and in a quark-gluon plasma. For low mass dilepton pairs this effect reduces the production rate for bremsstrahlung by an order of magnitude. For high invariant masses its influence is negligible. This behaviour is of importance for the theoretical analysis of low mass dilepton pairs produced in relativistic heavy ion collisions.

6698 (LBL–34831, pp. 197-206) **Classical and quantum coherence in bremsstrahlung.** Knoll, J. (Gesellschaft fuer Schwerionenforschung (GSI), Darmstadt (Germany)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Recent considerations about the importance of coherence effects for bremsstrahlung in dense matter (Landau-Pomerancuk-Migdal-effect) are presented and extended for the application to QCD transport and parton kinetic models. Low energy (soft limit) theorems are discussed and pocket correction formulae for the in-matter radiation cross sections are derived using the experience from an exactly solvable hard-scattering model. In contrast to recent derivations by others the author requires a stronger in-medium suppression factor of the form $(\omega\tau)^4/(1+(\omega\tau)^2)^2$ where ω is the energy of the radiated quantum and τ is the mean free time between successive collisions. This stronger suppression of e.g. gluon radiation implies an even weaker stopping power of high energy partons than discussed by Wang and Gyulassy.

6699 (LBL–34831, pp. 207-218) **Medium effects on heavy-ion dynamics.** Ko, Che Ming (Texas A&M Univ., College Station, TX (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. Grant PHY-9212209. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The property of hadrons in hot dense matter is reviewed. Incorporating the medium effects in the relativistic transport model, which consistently treats the change of hadron masses and energies in dense matter via the scalar and vector fields, the expansion stage of heavy-ion collisions at the AGS and CERN energies is studied. With the in-medium particle production cross sections, this model provides a plausible explanation for the observed enhancement of strange particle production and differences in the slope parameters of the kinetic energy spectra for particles and antiparticles.

6700 (LBL–34831, pp. 219-233) **Landau-Pomeranchuk effect in QCD and radiative energy loss.** Wang, Xin-Nian (Lawrence Berkeley Lab., CA (United States)); Gyulassy, M. Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract FG02-93ER40764 ; AC03-76SF00098. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Landau-Pomeranchuk effect, the suppression of soft bremsstrahlung due to multiple scatterings inside a dense medium, is investigated in perturbative QCD. An effective formation time of the radiation due to the color interference is obtained which depends on the color representation of the propagating jet parton. Using this effective formation time, the radiative energy loss is obtained which interpolates nicely between the factorization and Bethe-Heitler limits.

6701 (LBL–34831, pp. 243-256) **Quark-gluon plasma freeze-out from a supercooled state?.** Csoergo, T. (KFKI RMKI, Budapest (Hungary)); Csernai, L.P. Lawrence Berkeley Lab., CA (United States). [1993]. Grant NFR/NAVF-422.93/008; Grant NFR/NAVF-422.93/011; Grant OTKA (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors consider time-scales of first-order deconfinement or chiral-symmetry restoring phase transition in high energy heavy ion collisions at RHIC and LHC energies. Recently, it was shown that the system must supercool below T_c before the nucleation of hadronic bubbles is sufficiently rapid to overcome the expansion rate. It is shown here that the expected time-scales of high energy heavy ion reactions are sufficiently short to prevent the reheating of the system to near T_c. If quark-gluon plasma is produced in these collisions, it may have to hadronize from a supercooled state and the hadrons produced during rehadronization may freeze-out almost immediately.

6702 (LBL–34831, pp. 257-263) **Effective action of a QCD chiral order parameter.** Elze, H.T. (CERN-Theory, Geneva (Switzerland)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

Density fluctuations in small phase space bins for centrally produced particles (mainly pions) are conveniently parametrized by a Gaussian free energy functional of the density fluctuation field. This observation leads to the investigation of the O(N) linear σ-model; the O(4) version may represent the QCD chiral order parameter in the case of two approximately massless quark flavours. The author derives a non-perturbative and finite equation for its finite temperature effective action in terms of scalar and pseudo-scalar iso-vector (meson) fields. In the large-N limit, well-known results on the nature of the phase transition are recovered. Thus, one obtains the Ginzburg-Landau theory for a QCD system in thermodynamic equilibrium.

6703 (LBL–34831, pp. 265-281) **Soft interaction, intermittency and phase transition.** Hwa, R.C. (Univ. of Oregon, Eugene, OR (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. DOE Contract FG06-91ER40637. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The importance of understanding soft interaction is discussed. It is shown how the Geometrical Branching Model can reproduce all

the low-p_T data on hadronic collisions, including fluctuations. Arguments are given on why intermittency data on nuclear collisions can reveal signatures of collective behavior. Scaling properties of hadronic observables when a quark-gluon plasma undergoes a phase transition are shown to possess a universal feature independent of unknown details of the system. The problem of cluster growth is also considered, and the possibility of a novel signature of quark-gluon plasma is suggested.

6704 (LBL–34831, pp. 283-292) **Non-perturbative effects in the SU(3)-gluon plasma.** Rischke, D.H. (Institut fuer Theoretische Physik der Universitaet, Frankfurt (Germany)); Gorenstein, M.I.; Schaefer, A.; Stoecker, H.; Greiner, W. Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors investigate lattice data for the thermodynamical functions of the SU(3) pure gauge theory and propose a phenomenological equation of state which is able to reproduce these data. Their results suggest that even at high temperatures only gluons with large momenta are deconfined, while gluons with small momenta cluster into glueball states. Therefore, the gluon plasma is not an ideal gas of gluons, but rather a "gluon-cluster" plasma.

6705 (LBL–34831, pp. 293-304) **Colour confinement in hadron-nucleus collisions.** Kharzeev, D. (Moscow State Univ. (Russian Federation)); Satz, H. Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors study the evolution of colour confinement in hadron-nucleus collisions and determine the resulting x_F dependence for the suppression of quarkonium production on nuclear targets. The Landau-Pomeranchuk effect applied to colour bremsstrahlung is shown to play a considerable role in the form of the suppression.

6706 (LBL–34831, pp. 305-312) **Modelling coherence and chaos in high-energy collisions.** Wilk, G. (Soltan Institute for Nuclear Studies, Warsaw (Poland)); Wlodarczyk, Z.; Weiner, R.M. Lawrence Berkeley Lab., CA (United States). [1993]. Grant 2-0957-91-01; Grant 2-0423-91-01. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The quantum statistical concepts of coherence and chaos used to describe fluctuations in multiparticle production processes are incorporated in a generalized Monte Carlo version of the Interacting Gluon Model (IGM). The two components in the multiplicity distributions found previously are identified as originating from the two components of the energy flow existing in the IGM: the one provided by the interacting gluons and the other related to the initial valence quarks of the projectiles.

6707 (LBL–34831, pp. 321-328) **Bose-condensates in high energy nucleus-nucleus collisions.** Ornik, U. (Theory Group, Darmstadt (Germany)); Pluemer, M.; Strottman, D. Lawrence Berkeley Lab., CA (United States). [1993]. Grant 06MR731. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The conditions necessary for the formation of a superfluid component in an expanding system of excited matter created in nuclear collisions are investigated. For a realistic resonance gas equation of state, it is found that the decoupling from local chemical equilibrium must occur at high temperatures and baryon number densities for a sizable amount of condensate to be formed.

6708 (SLAC-PUB–6618) **Studies of strong electroweak symmetry breaking at future e^+e^- linear colliders.** Barklow, T.L. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-940816–53: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004281. Source: OSTI; NTIS; INIS; GPO Dep.

Methods of studying strong electroweak symmetry breaking at future e^+e^- linear colliders are reviewed. Specifically, we review precision measurements of triple gauge boson vertex parameters and the rescattering of longitudinal W bosons in the process $e^+e^- \rightarrow W^+W^-$. Quantitative estimates of the sensitivity of each technique to strong electroweak symmetry breaking are included.

6623 Specific Interactions, Decays and Processes

Refer also to citation(s) 6367, 6708, 6750, 6751, 6752, 6753, 6754, 6755, 6756, 6786

6709 (ANL-HEP-CP–94-66) **Polarization and N-N elastic scattering amplitudes.** Ramsey, G.P. (Loyola Univ., Chicago, IL (United States). Dept. of Physics). Argonne National Lab., IL (United States). 7 Oct 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9409103–9: International symposia on high energy spin physics and polarization phenomena in nuclear physics, Bloomington, IN (United States), 15-22 Sep 1994). Order Number DE95004648. Source: OSTI; NTIS; INIS; GPO Dep.

We discuss the role of polarization measurements and scattering amplitudes for elastic nucleon-nucleon processes at high energy. The relative normalization of these amplitudes involves a "leading order form factor" which we determine empirically. These amplitudes provide an economical description of a large body of existing data and make some nontrivial predictions for spin observables. In particular, we have investigated cross sections and asymmetry data at large angles (including 90° c.m.) and the fixed $|t|$, large s region, dominated by the three-gluon exchange mechanism. Our results indicate that polarization experiments can test basic QCD elements such as helicity conservation, wave function properties and the interplay between various interaction mechanisms. The significance of this analysis will be discussed in terms of specific polarization experiments, which can be performed at Fermilab and Brookhaven (RHIC.AGS).

6710 (ANL-HEP-TR–94-60) **High Energy Physics Division semiannual report of research activities, January 1, 1994–June 30, 1994.** Argonne National Lab., IL (United States). Sep 1994. 72p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95003985. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the research conducted in the High Energy Physics Division of Argonne National Laboratory during the period of January 1, 1994-June 30, 1994. Topics covered here include experimental and theoretical particle physics, advanced accelerator physics, detector development, and experimental facilities research. Lists of division publications and colloquia are included.

6711 (DESY–93-016) **Rare B-decays in the standard model.** Ali, A. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany)); Greub, C.; Mannel, T. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Feb 1993. 36p. (ZU-TH–4/93; IKDA–93/5). Order Number DE95733431. Source: OSTI; NTIS (US Sales Only); INIS.

We review theoretical work done in studies of the Flavour Changing Neutral Current (FCNC) B-decays in the context of the Standard Model. Making use of the QCD-improved effective Hamiltonian describing the so-called vertical stroke ΔBvertical stroke =1 and vertical stroke ΔBvertical stroke =2, vertical stroke ΔQvertical stroke =0 transitions, we calculate the rates and differential distributions in a large number of B-decays. The FCNC processes discussed here include the radiative decays $B \rightarrow X_s + \gamma$, $B \rightarrow X_d + \gamma$, and the semileptonic decays $B \rightarrow X_s l^+l^-$, $B \rightarrow X_d l^+l^-$, $B \rightarrow X_s \nu_l$ anti ν_l, and $B \rightarrow X_d \nu_l$ anti ν_l. We also discuss the inclusive photon energy spectrum calculated from the Charged Current (CC) decays $B \rightarrow X_c + \gamma$ and $B \rightarrow X_u + \gamma$ and the mentioned FCNC radiative decays. The importance of carrying out measurements of the inclusive photon energy spectrum in B-decays is emphasized. Using phenomenological potential models and the Heavy Quark Effective Theory (HQET) we estimate decay branching ratios in a number of exclusive FCNC B-decays. Purely leptonic and photonic

decays (B_d, B_s) → l^+l^- and (B_d, B_s) → $\gamma\gamma$ are also estimated. The principal interest in the studies of FCNC B-decays lies in their use in determining the parameters of the standard Model, in particular the CKM matrix elements and the top quark mass. The parametric dependence of these and other QCD-specific parameters on the rates and distributions is worked out numerically. (orig.)

6712 (DESY–94-077) **τ- μ- e universality in τdecays and constraints on the slepton masses.** Chankowski, P.H. (Istituto Nazionale di Fisica Nucleare, Padua (Italy)); Hempfling, R.; Pokorksi, S. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). May 1994. 17p. (DFPD–94/TH-27; MPI-PhE–94-28; HEP-PH–9405281). Order Number DE95725967. Source: OSTI; NTIS (US Sales Only); INIS.

The leptonic τ decays are calculated at the 1-loop level in the Minimal Supersymmetric Standard Model. The deviation from the τ-μ-e universality is studied as a function of the supersymmetric parameters and discussed in the context of the expected improvement of the experimental accuracy. (orig.)

6713 (DESY–94-114) **BFKL versus O(α^3_s) corrections to large-rapidity dijet production.** Del Duca, V. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany)); Schmidt, C.R. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 25p. (SCIPP–94/17; HEP-PH–9407359). Order Number DE95725968. Source: OSTI; NTIS (US Sales Only); INIS.

We examine dijet production at large rapidity intervals at Tevatron energies by comparing an exact OMIKRON (α_s^3) calculation with the BFKL approximation, which resums the leading powers of the rapidity interval y to all orders in α_s. We analyze the dependence of the exact OMIKRON (α_s^3) calculation on the jet cone-size as a function of y, and use this cross section to define an 'effective rapidity' y which reduces the error that the large-y approximation induces on the kinematics. Using y in the BFKL resummation, we reexamine jet production at large transverse momenta and the transverse momentum decorrelation of the tagging jets. We find less dramatic, but still significant, effects than found previously using the large-y approximation. (orig.)

6714 (DESY–94-120) **Determination of the structure of τdecays in the reaction $e^+e^- \to \tau^+\tau^- \to \rho^+$ anti $\nu_\tau\rho^-\nu_\tau$ and a precision measurement of the τ-neutrino helicity.** Albrecht, H.; Hamacher, T.; Hofmann, R.P.; Kirchhoff, T.; Mankel, R.; Nau, A.; Nowak, S.; Ressing, D.; Schroeder, H.; Schulz, H.D.; Walter, M.; Wurth, R.; Hast, C.; Kapitza, H.; Kolanoski, H.; Kosche, A.; Lange, A.; Lindner, A.; Schieber, M.; Siegmund, T.;ARGUS Collaboration. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 14p. Order Number DE95725959. Source: OSTI; NTIS (US Sales Only); INIS.

Using the ARGUS detector at the DORIS II storage ring we have investigated the Lorentz structure of the electroweak interaction in semi-hadronic τ decays. Spin correlations in the process $e^+e^- \to \tau^+\tau^- \to$ anti $\nu_\tau\pi^+\pi^0$ $\nu_\tau\pi^-\pi^0$ are exploited for a measurement of the normalized product of the vector (g_V) and axial vector (g_A) couplings of the τ lepton, γ_{AV}=2 Re{$g_A g_V^*$}/(vertical stroke $g_V$vertical stroke ^{2}+vertical stroke $g_A$vertical stroke ^{2}). The correlations are sensitive to the product of the couplings in both τ decays: $\gamma_{AV}{}^2=\gamma_{AV}(\tau^- \to \nu_\tau W^-)\gamma_{AV}(\tau^+ \to$ anti $\nu_\tau W^+)$, which can be interpreted as the product of the neutrino helicities: $\gamma_{AV}{}^2$=-h(ν_τ)h(anti ν_τ). The measured value, $\gamma_{AV}{}^2$=1.044±0.057±0.060, determines the relative sign of the neutrino helicities. Assuming CP invariance, the absolute value {γ_{AV}}=1.022±0.028±0.030 was found to be in excellent agreement with the Standard Model. The contribution of scalar (g_S) or pseudoscalar (g_P) couplings was also investigated. No evidence for a scalar-like coupling was found. (orig.)

6715 (DESY–94-124) **Next-to-leading order fragmentation functions for pions and kaons.** Binnewies, J. (Hamburg Univ. (Germany). 2. Inst. fuer Theoretische Physik); Kniehl, B.A.; Kramer, G. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 35p. Order Number DE95725958. Source: OSTI; NTIS (US Sales Only); INIS.

We present new sets of fragmentation functions for charged pions and kaons, both at leading and next-to-leading order. They are fitted to TPC data taken at energy $\sqrt{s}$=29 GeV and describe excellently a wealth of other e^+e^- data on charged-hadron production, ranging from $\sqrt{s}$=5.2 GeV way up to LEP 1 energy. They also agree with data on the production of neutral pions and kaons, if one makes the natural assumption that the respective fragmentation functions are related to the charged counterparts by SU(2) symmetry. We also list simple parameterizations of the x and Q^2 dependence of our results, which may be implemented conveniently in applications. (orig.)

6716 (DESY–94-125) **SMATASY. A Program for the model independent description of the Z resonance.** Kirsch, S.; Riemann, T. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Jul 1994. 26p. Order Number DE95725960. Source: OSTI; NTIS (US Sales Only); INIS.

SMATASY is an interface for the $_{ZF}I^TT_{ER}$ package and may be used for the model independent description of the Z resonance at LEP 1 and SLC. It allows the determination of the Z mass and width and its resonance shape parameters r and j for cross-sections and their asymmetries. The r describes the peak height and j the interference of the Z resonance with photon exchange in each scattering channel and for σ_T, σ_{FB}, σ_{lr}, σ_{pol} etc. separately. Alternatively, the helicity amplitudes for a given scattering channel may be determined. We compare our formalism with other model independent approaches. The model independent treatment of QED corrections in SMATASY is applicable also far away from the Z peak. (orig.)

6717 (DESY–94-127) **Signals for supersymmetry at HERA.** Dreiner, H. (Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. fuer Theoretische Physik); Morawitz, P. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 36p. Order Number DE95725665. Source: OSTI; NTIS (US Sales Only); INIS.

We consider the baryon parity signals at HERA for the case of the MSSM production mechanisms and the decays via the lepton number violating couplings L_iQ anti D. We can probe very small Yukawa couplings $\lambda'>$ or $\approx 3.10^{-6}$, limited only by the decay length of the LSP. We assume the LSP to be the lightest neutralino and study its decays in detail. We present the matrix element squared for the tree-level decay amplitude of a generally mixed neutralino explicitly. We find that the branching fraction to charged leptons strongly depends on the SUSY parameters and can differ significantly from the naively expected 50%. The SUSY mass reaches of the studied processes in the ZEUS detector at HERA were found to be: (m(e, anti ν)+m(anti q)) $\leq$ 170 GeV, 195 GeV and 205 GeV for the L_1Q anti D, $L_\mu Q$ anti $\overline{D}$ and $L_\bullet Q$ anti D couplings respectively. These are well above existing limits on R-parity violating (R_p) SUSY from previous experiments. We conclude that HERA offers a very promising discovery potential for R_p SUSY. (orig.)

6718 (DESY–94-131) **Recombination effects in the structure function evolution at low x. Can they be observed at HERA?.** Golec-Biernat, K. (Institute of Nuclear Physics, Cracow (Poland)); Krasny, M.W.; Riess, S. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Jul 1994. 12p. Order Number DE95725957. Source: OSTI; NTIS (US Sales Only); INIS.

Can the non-linear QCD effects resulting from parton recombination be detected at HERA by the H1 and ZEUS detectors? We argue that an extension of the low x domain of the proton structure function F_2 measurements to small electron scattering angle is essential before they can be ruled out. If, on the other hand, they are large, we find that their magnitude cannot be determined unambiguously from the measured Q^2 and x dependence of F_2. This is due to large correlations between the size of recombination effects and the gluon distribution which is very weakly constrained at low x by the F_2 evolution. (orig.)

6719 (DESY–94-136) **Inclusive photoproduction of hadrons at HERA. - Direct photon production at LEP and HERA.** Kniehl, B.A. (Hamburg Univ. (Germany). 2. Inst. fuer Theoretische Physik); Kramer, G. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 19p. (CONF-9405266–: Workshop on two-photon physics at LEP and HERA: status of data and models, Lund (Sweden), 26-28 May 1994). Order Number DE95725663. Source: OSTI; NTIS (US Sales Only); INIS.

Matrix element calculations for the decay of the Z into one isolated photon plus n jets are reviewed. The problem of photon

isolation with respect to quark, antiquark and gluon is discussed in detail. Experimental results of the LEP collaborations are compared to the theory. Theoretical results for γ+n jet production in deep inelastic ep collisions at HERA are presented also. (orig.)

6720 (DESY–94-138) **A search for heavy leptons at HERA.** Ahmed, T.; Aid, S.; Andreev, V.; Andrieu, B.; Appuhn, R.D.; Arpagaus, M.; Babaev, A.; Baehr, J.; Ban, J.; Baranov, P.; Barrelet, E.; Bartel, W.; Barth, M.; Bassler, U.; Beck, H.P.; Behrend, H.J.; Belousov, A.; Berger, C.; Bergstein, H.; Bernardi, G.; BerneH1 Collaboration. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 19p. Order Number DE95732221. Source: OSTI; NTIS (US Sales Only); INIS.

A search for direct production of new leptons in the mass range from 10 GeV up to 225 GeV is presented by the H1 experiment at HERA. The data were obtained during 1993 and correspond to an integrated luminosity of 528 nb^{-1}. The search includes heavy lepton decays to final states $e(\nu)\gamma$ and $e(\nu)W$, $e(\nu)Z$ with the subsequent decay of the W and Z bosons into jets or lepton pairs. No evidence was found for the production of new massive electrons or neutrinos in any of the decay channels. Rejection limits for excited electrons and neutrinos are derived. (orig.)

6721 (DESY–94-139) **Measurement of the polarization in the decay B $\rightarrow J/\psi K^*$.** Albrecht, H.; Hamacher, T.; Hofmann, R.P.; Kirchhoff, T.; Mankel, R.; Nau, A.; Nowak, S.; Ressing, D.; Schroeder, H.; Schulz, H.D.; Walter, M.; Wurth, R.; Hast, C.; Kapitza, H.; Kolanoski, H.; Kosche, A.; Lange, A.; Lindner, A.; Schieber, M.; Siegmund, T.;ARGUS Collaboration. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 7p. Order Number DE95732177. Source: OSTI; NTIS (US Sales Only); INIS.

Polarization in the exclusive decay $B\rightarrow J/\psi K^*$ was measured using the ARGUS detector at the e^+e^- storage ring DORIS II. The ratio of the transverse to the total decay width was found to be $\Gamma_T/\Gamma=0.03\pm0.16\pm0.15$. This measurement demonstrates that the $B^0\rightarrow J/\psi K^{*0}$ decay channel can be effectively used for CP violation studies. (orig.)

6722 (DESY–94-140) **Diffractive photoproduction of jets with a direct pomeron coupling at HERA.** Kniehl, B.A. (Hamburg Univ. (Germany). 2. Inst. fuer Theoretische Physik); Kohrs, H.G.; Kramer, G. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 30p. (KEK-TH–407; KEK–94-77(prepr.); HEP-PH–9408340). Order Number DE95725659. Source: OSTI; NTIS (US Sales Only); INIS.

We investigate in detail the effect of a direct pomeron coupling to quarks on the production of jets in ep scattering with almost real photons. Jet production via a direct pomeron coupling is compared with the resolved-pomeron mechanism. We consider both direct and resolved photoproduction. Rapidity and transverse momentum distributions are calculated and compared with preliminary H1 and ZEUS data. (orig.)

6723 (DESY–94-144) **Leptoquark production at high energy e^+e^- colliders.** Bluemlein, J. (Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik); Boos, E. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Aug 1994. 15p. (CONF-9404210–: Zeuthen workshop on elementary particle theory: Physics at LEP200 and beyond, Teupitz (Germany), 10-15 Apr 1994). Order Number DE95725660. Source: OSTI; NTIS (US Sales Only); INIS.

The prospects to search for scalar and vector leptoquarks at high energy e^+e^- colliders are reviewed. We compare production cross sections in the energy range between $\sqrt{s}$=O(200 GeV) and 1 TeV for e^+e^- annihilation. QED and QCD corrections and the effect of beamstrahlung in these processes are discussed. For the case of linear colliders the search potential in the different possible collider modes as e^+e^- annihilation, $e^\pm\gamma$ scattering, and $\gamma\gamma$ fusion is compared. (orig.)

6724 (DESY–94-149) **Small x contributions to the structure function $F_L(x,Q^2)$.** Bluemlein, J. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Aug 1994. 5p. (CONF-9407135–: QCD 94: nuclear physics B, Montpellier (France), 7-13 Jul 1994; HEP-PH–9408377). Order Number DE95725567. Source: OSTI; NTIS (US Sales Only); INIS.

The gluon contributions to $F_L(x, Q^2)$ in $O(\alpha_s)$ are calculated taking into account the transverse momentum of the initial state parton. In comparison with collinear factorization $F_L(x, Q^2)$, is not affected at large x but takes smaller values in the small x range. The onset of the $k_\perp$ effect is a function of Q^2. (orig.)

6725 (DESY–94-153) **Photoproduction of J/ψmesons at HERA.** Ahmed, T.; Aid, S.; Andreev, V.; Andrieu, B.; Appuhn, R.D.; Arpagaus, M.; Babaev, A.; Baehr, J.; Ban, J.; Baranov, P.; Barrelet, E.; Bartel, W.; Barth, M.; Bassler, U.; Beck, H.P.; Behrend, H.J.; Belousov, A.; Berger, C.; Bergstein, H.; Bernardi, G.; BerneH1 Collaboration. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Aug 1994. 16p. Order Number DE95731948. Source: OSTI; NTIS (US Sales Only); INIS.

We present a study of J/ψ meson production in collisions of 26.7 GeV electrons with 820 GeV protons, performed with the H1-detector at the HERA collider at DESY. The J/ψ mesons are detected via their leptonic decays both to electrons and muons. Requiring exactly two particles in the detector, a cross section of $\sigma(ep\rightarrow J/\psi X)=(8.8\pm2.0\pm2.2)$ nb is determined for 30 GeV$\leq W_{\gamma p}\leq$180 GeV and $Q^2<$ or $\approx$4 GeV^2. Using the flux of quasi-real photons with $Q^2<$ or $\approx$4 GeV^2, a total photoproduction cross section of $\sigma(\gamma p\rightarrow J/\psi X)=(56\pm13\pm14)$ nb is derived at an average $W_{\gamma p}$=90 GeV. The distribution of the squared momentum transfer t from the proton to the J/ψ can be fitted using an exponential exp(-bvertical stroke tvertical stroke) below avertical stroke tvertical stroke of 0.75 GeV^2 yielding a slope parameter of $b=(4.7\pm1.9)$ GeV^{-2}. (orig.)

6726 (DESY–94-155) **Low x physics and perturbative Regge asymptotics.** Kirschner, R. Deutsches Elektronen-Synchrotron (DESY), Zeuthen (Germany). Inst. fuer Hochenergiephysik. Aug 1994. 17p. (CONF-9406273–: Tennessee international symposium on radiative corrections, Gatlinburg, TN (United States), 27 Jun - 1 jul 1994). Order Number DE95731933. Source: OSTI; NTIS (US Sales Only); INIS.

Deep-inelastic scattering at small x is a new field of QCD phenomenology which HERA experiments started to explore. The data show the feature expected by the perturbative Regge asymptotics. We describe the parton picture of structure function evolution both for increasing Q^2 and for decreasing x and discuss the leading logarithmic approximation of QCD on which this picture is based. The steep rise of the parton density towards smaller x gets saturated by parton recombination. An essential improvement of the leading logarithmic approximation has to be worked out in order to satisfy the unitarity conditions and in this way to describe the parton recombination in perturbative QCD. We review some ideas of the perturbative Regge asymptotics and some recent theoretical results about multi-reggeon exchange in QCD. (orig.)

6727 (DESY–94-178) **Deep inelastic structure functions from HERA.** Wolf, G. Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany). Oct 1994. 20p. (CONF-9405216–: Neutrino '94: 16th international conference on neutrino physics and astrophysics, Eilat (Israel), 29 May - 3 jun 1994). Order Number DE95731368. Source: OSTI; NTIS (US Sales Only); INIS.

Results on deep inelastic scattering obtained by H1 and ZEUS from the 1993 data taken at HERA are presented. The measurements of the charged current process provide first evidence for the damping of the total neutrino cross section at high energies by the W propagator. A comparison with neutral current scattering shows that at Q^2 values above the W mass squared the weak cross section becomes comparable to the electromagnetic one. The structure function F_2 of the proton was determined from neutral current scattering data. The results confirm the steep rise of F_2 towards small x below 10^{-2} seen previously by the two experiments albeit with much less statistics. The rise persists from the lowest Q^2 values up to 500 GeV^2. The F_2 data are in accord with logarithmic scaling violations in a new regime of low x and high Q^2. An analysis of F_2 data by ZEUS in terms of the total virtual photon proton corss section shows $\sigma_{tot}(\gamma^*p)$ to increase with the total γ^*p c.m. energy, the increase being compatible with a linear rise. This

is in striking contrast with the behaviour of the total cross section for real photons or for anti pp scattering. (orig.)

6728 (DOE/ER/40310–T3) **Photon detector for MEGA. Final report, July 16, 1992–May 31, 1993.** Gagliardi, C.A.; Tribble, R.E. Texas A and M Univ., College Station, TX (United States). [1993]. 26p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-87ER40310. Order Number DE95003828. Source: OSTI; NTIS; INIS; GPO Dep.

During the past year, we have continued our work on the photon detector for the MEGA experiment at Los Alamos. The MEGA photon detector is designed to observe the 52.83 MeV photon produced in a $\pi \rightarrow e\gamma$ decay with an energy resolution of 1.25 MeV, a position resolution of 2×5 mm^2, a directional resolution of 10°, a time resolution of 500 ps, and an efficiency of about 5.4%. (All quoted resolutions are FWHM.) It consists of three independent concentric cylindrical pair spectrometers mounted within a 1.5 T magnetic field produced by a superconducting solenoid magnet. Each pair spectrometer includes two thin (0.045 radiation lengths each) Pb foils to convert photons into e^+e^- pairs. The two smaller pair spectrometers have three drift chamber layers to track the e^+e^- pairs and thereby determine both their locations and their vector momenta. The third pair spectrometer has four layers of drift chamber, together with a larger turning region, to provide better tracking information for high energy photons such as those from the $\pi^0 \rightarrow 2\gamma$ decay.

6729 (DOE/ER/40822–1) **[Accelerator physics R&D].** Krisch, A.D. Michigan Univ., Ann Arbor, MI (United States). 22 Aug 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-94ER40822. Order Number DE95003624. Source: OSTI; NTIS; INIS; GPO Dep.

This report discusses the NEPTUN-A experiment that will study spin effects in violent proton-proton collisions; the Siberian snake tests at IUCF cooler ring; polarized gas jets; and polarized proton acceleration to 1 TeV at Fermilab.

6730 (FNAL/C–94/289-E) **Search for new gauge bosons at Dv.** D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–63: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003745. Source: OSTI; NTIS; INIS; GPO Dep.

The authors have searched for evidence of $W' \rightarrow e\nu$ and $Z' \rightarrow ee$ in data collected with the Dv detector at the Tevatron during the 1992–1993 $p\bar{p}$ collider run at $\sqrt{s} = 1.8$ TeV. They exclude the existence of a W′ of mass less than 600 GeV/c^2 and a Z′ of mass less than 480 GeV/c^2 at the 95% confidence level, assuming standard model couplings to quarks and leptons.

6731 (FNAL/C–94/294-E) **A search for $t\bar{t} \rightarrow$ lepton + E_T + jets signature in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV with the D0 detector.** Chakraborty, D. (State Univ. of New York, Stony Brook, NY (United States). Dept. of Physics). D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–65: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004239. Source: OSTI; NTIS; INIS; GPO Dep.

The authors report the results from a search for $t\bar{t}$ production in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV with the D0 detector at Fermilab in the final states consisting of one isolated high p_T lepton (e or μ), multiple jets and a substantial missing transverse energy (E_T), excluding the events that have μ-tagged jets. Two independent analysis approaches lead them to similar estimates for the cross-section. They see no conclusive evidence for top production in the 13.5 pb^{-1} of data taken during the 1992–1993 run of the Tevatron.

6732 (FNAL/C–94/306-E) **Electroweak boson pair production at the Tevatron.** Errede, S.M. (Univ. of Illinois, Urbana, IL (United States). Loomis Lab. of Physics). Fermi National Accelerator Lab., Batavia, IL (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940722–35: 27. international conference on high energy physics, Glasgow (United Kingdom), 21-27 Jul 1994). Order Number DE95004234. Source: OSTI; NTIS; INIS; GPO Dep.

Preliminary results from CDF and Dv on $W\gamma$, $Z\gamma$ and WW, WZ, ZZ boson pair production in $\sqrt{s} = 1.8$ TeV $\bar{p}$-p collisions from the 1992–93 collider run are presented. Direct limits on CP-conserving and CP-violating $WW\gamma$, WWZ, $ZZ\gamma$ and $Z\gamma\gamma$ anomalous couplings have been obtained. The results are consistent with Standard Model expectations. In the static limit, the direct experimental limits on $WW\gamma$ and $ZZ\gamma$ anomalous couplings are related to bounds on the higher-order static (transition) EM moments of the W(Z) bosons. Expectations from the on-going and future Tevatron collider runs are discussed.

6733 (FNAL/C–94/329-E) **Measurement of the $WW\gamma$, $ZZ\gamma$ and $Z\gamma\gamma$ couplings at the Fermilab Tevatron.** Ellison, J. (California Univ., Riverside, CA (United States). Dept. of Physics). The D0 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–59: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003495. Source: OSTI; NTIS; INIS; GPO Dep.

The processes $p\bar{p} \rightarrow \ell\bar{\nu}_\gamma + X$ and $p\bar{p} \rightarrow \ell^+\ell^-_\gamma + X$ ($\ell = e, \mu$) have been observed using the DO detector at the Fermilab Tevatron Collider at $\sqrt{s} = 1.8$ TeV. The observed signals in the electron and muon decay channels are used as a probe of the $WW\gamma$, $ZZ\gamma$, and $Z\gamma\gamma$ vertex couplings. By comparing the event rates and shapes of the photon ET distributions with theoretical predictions, 95% confidence limits are obtained on the $WW\gamma$, $ZZ\gamma$, and $Z\gamma\gamma$ vertex coupling parameters.

6734 (FNAL/C–94/330-E) **A study of events with large total transverse energy produced in proton-antiproton collisions at $\sqrt{s} = 1.8$ TeV.** Piekarz, H. (Florida State Univ., Tallahassee, FL (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–61: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003382. Source: OSTI; NTIS; INIS; GPO Dep.

Properties of events originating from proton-antiproton interactions in which the total transverse energy, $\Sigma|E_T|$, of the event exceeded 400 GeV are presented. These events were produced at the Fermilab Tevatron Collider operating at a center-of-mass energy of 1.8 TeV and recorded in the D0 detector. The authors describe their analysis method which minimizes the effect of multiple interactions in the data sample. Based on a data sample of 5.45 ± 0.65 pb^{-1}, the topology of these hard scattering events as well as preliminary results for the cross-section, $d\sigma/d\Sigma|E_T|$, are presented and discussed.

6735 (FNAL/C–94/365-E) **Recent results from Fermilab E-687, charm particle decays, lifetimes and photoproduction dynamics: A compilation results presented at DPF 1994.** E687 Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–Pt.1: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004580. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains papers on the following topics: Recent results on the semi-leptonic decay Decay $D^0 \rightarrow K^-\mu^+\nu_\mu$; charmed mesons; observation of the Decay $\Omega_c{}^0\Sigma^+K^-K^-\phi^+$; the physics of charm lifetimes; and photoproduction of charmed hadrons. These papers have been cataloged separately.

6736 (FNAL/C–94/374-E) **Search for top quark at CDF.** CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Nov 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-9409134–1: Conference on high energy physics: hadron structure, Kosice (Slovakia), 19-23 Sep 1994). Order Number DE95003748. Source: OSTI; NTIS; INIS; GPO Dep.

There is a vast theoretical and experimental support for idea that op quark as a weak isospin partner to b-quark should exist. Production cross section is steeply falling function of top quark mass. Therefore realistically at present only Tevatron $p\bar{p}$ collider at FNAL, with total energy 1.8 TeV in CMS system, still has a chance of top quark discovery. Dominant production mechanism for top quarks at Tevatron is pair production of $t\bar{t}$. With almost 100% probability t ($\bar{t}$) decays in mode $t \rightarrow W^+b$. Distinct features of this decay provide very good signatures of top quark production which helps to reduce otherwise very high level of background. Based on simple combinatorial arguments one can show that W should decay in 1/9 cases into $W \rightarrow l + \nu$ where l stands for lepton (e,μ,τ). Very clean signature represents case when both W's from t and $\bar{t}$ decay into e (μ) + ν. In this case experimental observation will be two isolated leptons characterized by large transverse momentum, large missing transverse energy E_T and 2 b quark jets. Jets originated from b quarks can be quite frequently recognized by presence of secondary vertices associated with jets. Another feature of b-jets which can be used for their identification is frequent association of so called soft leptons with jets. Two experimental setups CDF and D0 are able to take advantage of Tevatron for top quark discovery. Recently CDF collaboration presented evidence for direct observation of $t\bar{t}$ production in 19.3 pb^{-1} of $p\bar{p}$ collisions at $\sqrt{(s)}$ = 1.8TeV. Very brief account of these results is presented here.

6737 (GSI–94-55(prepr.)) **Prompt photon production in p-p collisions.** Cleymans, J. (Cape Town Univ. (South Africa). Dept. of Physics); Quack, E.; Redlich, K.; Srivastava, D.K. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany). Sep 1994. 35p. Order Number DE95725941. Source: OSTI; NTIS (US Sales Only); INIS.

A systematic study of the inclusive photon cross-section in p-p collisions is presented. The dependence of the γ rates on the renormalization and factorization scales is discussed. A comparison is made with experimental data for centre-of-mass energies ranging from 23 GeV to 1.8 TeV. Predictions of the cross-sections are given for two different sets of structure functions for RHIC and LHC energies. (orig.)

6738 (INIS-mf–14421, pp. 28-37) **Strangeness production experiments at SATURNE.** Ernst, J. (Bonn Univ. (Germany). Inst. fuer Strahlen- und Kernphysik). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

Results of three strangeness production experiments at SATURNE are presented using the high resolution magnetic spectrometer SPES4. In two experiments outgoing K^+ particles are detected at forward angles. The kaons were separated from an immense background of protons and pions by time-of-flight (TOF) and Cerenkov detectors. In the third experiment outgoing ^{3}He was measured and identified by TOF, only. The associated strangeness production in pp collisions was studied at bombarding energies of 2.3 and 2.7 GeV. The hyperon-nucleon missing mass spectra obtained show partly strong deviations from pure phase space which is ascribed to final state interactions of the pΛ and the NΣ systems. The structures found are discussed and compared with results from K^-d to π^-YN experiments, with theoretical calculations in the frame of one-boson-exchange (OBE) models, and with the prediction of sharp strange dibaryon resonances from certain quark-bag models. Cross sections for the associated strangeness production of light hypernuclei via the reactions (p,K^+) were measured for 2 GeV proton beams with the targets D,^{3}He and ^{4}He. Upper limits were obtained and are compared with theoretical estimates considering the effects of large momentum mismatch and short range correlations. A previous meson exchange model is being extended to allow for exclusive production of η and K^+ particles in addition to π's. The threshold excitation curve for meson production in the D(p,^{3}He)X reaction was measured by matching the incident beam energy and the ^{3}He momentum such that meson X is produced at rest in CM. The measurements show apparent signals at the ω-,η', and Φ-threshold while the vicinity of the mass of the predicted KK-tilde molecules no clear indication for their existence was found. 8 figs., 1 tab, 19 refs. (orig.).

6739 (INIS-mf–14421, pp. 70-79) **Meson Production studies at COSY.** Machner, H. (Forschungszentrum Juelich GmbH (Germany)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

The new accelerator Cosy at Juelich is shortly described. The first approved experiments and their detectors are presented. The experiments are measurements of elastic proton-proton scattering and two meson production in the proton-deuteron interactions with a ^{3}He-recoil and in the proton-proton interactions. Further experiments make use of a time of flight apparatus. These include production of photons, associated strangeness and η's in proton-proton interactions. Experiments with a hybrid detector (Ge-wall plus Magnet spectrometer) will search for pionic atoms in low lying states and neutral meson production in proton plus deuteron reactions. 10 figs., 13 refs. (orig.).

6740 (INIS-mf–14421, pp. 228-241) **On the spectroscopy of Σ^--hypernuclei.** Petridou, Th. (Thessaloniki Univ. (Greece)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

The (K^-,π^+)Σ^--hypernuclei spectra are studied in the context of the Green function method, using a simple potential model with a square well central part and a delta function spin-orbit Σ-nuclear-core interaction. Comparisons are made between the theoretical results and the in-flight (K^-,π^+) experimental data for $^{12}_{\Sigma}$C of the CERN and the late BNL data for $^{16}_{\Sigma}$O of the early BNL and the CERN data and for $^{6}_{\Sigma}$Li of the early BNL data for θ=13°,9°. A shallow potential, with a central potential depth of V_c=(-5-i15)MeV and a spin-orbit depth of V_{so}=15MeV, gives a satisfactory representation for these spectra. An investigation of the in-flight spectra is also made for different values of the potential parameters. The at rest spectra for $^{12}_{\Sigma}$C are calculated for two values of the potential. It is concluded that the possibility of the existence of peaks within this model for both the in-flight and the at rest spectra is related with a potential with strong or medium real and spin-orbit parts and a weak imaginary part. This simplified model, which facilitates the calculations, reaches the same conclusions with the more complicated models. 17 figs., 47 refs. (orig.).

6741 (INS–1045) **Pion-pair production by two photons.** Terazawa, Hidezumi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1994. 12p. Order Number DE95737162. Source: OSTI; NTIS; INIS.

The cross section for pion-pair production by two photons is calculated approximately by using the low energy theorem previously derived from partially-conserved-axial-vector-current hypothesis and current algebra, and found to agree very well with the experimental data recently obtained by the Mark II, TPC/Two-Gamma and CLEO Collaborations. (author).

6742 (INS–1055) **Double-strangeness five-body system.** Myint, K.S. (Mandalay Univ. (Myanmar). Dept. of Physics); Akaishi, Yoshinori. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Sep 1994. 25p. Order Number DE95737277. Source: OSTI; NTIS; INIS.

We perform theoretical analysis on the structure and decay of a double-strangeness five-body system which consists of $_{\Lambda\Lambda}{}^5$H and $_{\Xi}{}^5$H states. In this S=-2 five-body system the thresholds of the t$\Lambda\Lambda$ channel and the $\alpha\Xi^-$ channel come closer with only 8.51 MeV difference. We treat both bound and resonant states of the three-body channels t$\Lambda\Lambda$ and tpΞ^- by applying a complex rotation method. It is found that there is a bound $_{\Lambda\Lambda}{}^5$H state with 6.3 MeV

below the threshold of t+Λ+Λ. In the Ξ^- channel a resonant $_{\Xi}{}^5$H state appears at 1.7 MeV below the threshold of $\alpha+\Xi^-$. Though the existence of this state is ensured by the Coulomb interaction, it is a 'halo' nuclear state rather than an atomic state as judged from its size. The conversion width of this state is 0.2 MeV which is extremely narrow. It is also found that Ξ mixing into the $_{\Lambda\Lambda}{}^5$H ground state is small with 1.0 %. For the $_{\Lambda\Lambda}{}^5$H state, the weak decay to the $\alpha+\Sigma^-$ final state produces a high mono-energetic Σ^- with branching ratio of 5.5 %. Thus the Σ^- with discrete energy would become a clear signature of the forming of the ΛΛ hypernucleus. (author).

6743 (INS–1061) **Exotic states of hadronic atoms.** Yamazaki, Toshimitsu. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Sep 1994. 10p. Order Number DE95737276. Source: OSTI; NTIS; INIS.

Recently discovered metastable antiprotonic helium atoms are described. (author).

6744 (INS–1064) **Hadron-nucleon scattering lengths in QCD sum rules.** Morimatsu, Osamu. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Sep 1994. 13p. Order Number DE95737281. Source: OSTI; NTIS; INIS.

Recent progress of the QCD sum rule in its application to the calculation of hadron-nucleon scattering lengths is reported. After a brief introduction to the QCD sum rule, how to obtain scattering lengths in the QCD sum rule is explained. Then the results of its application are presented first for the pion-nucleon and kaon-nucleon channels and secondly for the nucleon-nucleon and hyperon-nucleon channels. (author).

6745 (LA-UR–94-3728) **Spin physics in the next decade.** Moss, J.M. (Los Alamos National Lab., NM (United States). Physics Div.). Los Alamos National Lab., NM (United States). [1994]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409103–8: International symposia on high energy spin physics and polarization phenomena in nuclear physics, Bloomington, IN (United States), 15-22 Sep 1994). Order Number DE95003727. Source: OSTI; NTIS; INIS; GPO Dep.

The author's personal opinion is that the fascinating field of nonperturbative QCD will be led by polarized beam experiments. He focuses on two developments which will surely produce a wealth of new physics within the next ten years. These are polarized colliding beams, and polarized jet targets in conjunction with polarized beams in storage rings. In order to make the overview manageable, he covers only selected areas where the physics goals are the elucidation of nonperturbative aspects of QCD applied to nucleons and nuclei. He discusses several areas of polarized structure function physics which will be feasible in the next 5–10 years.

6746 (LBL–34831, pp. 41-48) **Minijets in the two-component dual parton model in hadronic and heavy ion collisions.** Bopp, F.W. (Universitaet Siegen (Germany)); Pertermann, D.; Ranft, J.; Engel, R.; Kawrakow, I. Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors use new fits to parton structure functions, including structure functions with Lipatov behaviour at small x-values and discuss the minijet component in the two-component Dual Parton Model with a supercritical Pomeron as demanded by the fits to cross section data. They find, that a consistent model can only be formulated with a $p_{\perp thr}$ cut-off increasing with energy. The implications for particle production in hadronic and heavy ion collisions are discussed.

6747 (LBL–34831, pp. 235-242) **Signatures for QGP in dilepton spectrum.** Asakawa, M. (Texas A&M Univ., College Station, TX (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. Grant PHY-9212209; Grant A-1110. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The author discusses two ideas to verify the formation of the quark-gluon plasma in ultrarelativistic heavy ion collisions using dileptons. The most prominent feature that distinguishes the quark-gluon plasma from the hadron phase lies in the degree of freedom. This is reflected in the electromagnetic form factors. In the quark-gluon phase, quarks couple to the virtual photon directly. On the other hand, in the hadronic phase the degrees of freedom are hadrons and their couplings to the virtual photon are modified from the bare ones, which reflects the compositeness of hadrons. This simple fact makes it possible to distinguish dileptons from the two phases using the M_T scaling. Another trivial but interesting point is that if the quark-gluon plasma is created in heavy ion collisions, the system eventually must return to the normal hadronic phase. In this course, a phase transition takes place. Phase transition is characterized by the singular behavior of order parameters. If phase transition is first order, order parameters are not continuous at the phase transition point. If phase transition is second order, it is the first derivative of order parameters that is not continuous at the phase transition point.

6748 (SLAC-PUB–6601) **A study of K_s Λ and $\bar{\Lambda}$ production in hadronic Z^0 decays.** Baird, K.G. (Rutgers Univ., New Brunswick, NJ (United States)). SLD Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Aug 1994. 4p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract AC03-76SF00515. Contract PHY-9370976. (CONF-940816–54: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004280. Source: OSTI; NTIS; INIS; GPO Dep.

We present a preliminary measurement of the inclusive production rates of K_s, Λ and X hadrons produced in e^+e^- annihilation at the Z^0 pole. The analysis is based upon approximately 50K Z^0 decays collected in the SLD experiment at SLAC in 1993. The observed rates of $\langle K_s \rangle = 1.02 \pm 0.02 \pm 0.09$ and $\langle \Lambda \rangle + \langle \bar{\Lambda} \rangle = 0.38 \pm 0.01 \pm 0.04$ are consistent with previous measurements. Our differential cross section peak-position results are shown to be consistent with QCD predictions based on the modified leading logarithm approximation and local parton-hadron duality.

6749 (SLAC-PUB–6707) **Geometry of multihadron production.** Bjorken, J.D. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Oct 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9409257–1: 24. international symposium on multiparticle dynamics, Vietri sul Mare (Italy), 12-19 Sep 1994). Order Number DE95004290. Source: OSTI; NTIS; INIS; GPO Dep.

This summary talk only reviews a small sample of topics featured at this symposium: Introduction; The Geometry and Geography of Phase space; Space-Time Geometry and HBT; Multiplicities, Intermittency, Correlations; Disoriented Chiral Condensate; Deep Inelastic Scattering at HERA; and Other Contributions.

6624 Properties of Specific Particles and Resonances

Refer also to citation(s) 6684, 6733, 6740, 6745

6750 (BNL–60981) **Search for top in lepton + jets in D0 using a topological tag.** Protopopescu, S. D0 Collaboration. Brookhaven National Lab., Upton, NY (United States). [1994]. 5p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);CEA, 75 - Paris (France);Russian Atomic Energy Commission, Moscow (Russian Federation);Conselho Nacional de Desenvolvimento Cientifico e Tecnolo DOE Contract AC02-76CH00016. (CONF-940722–36: 27. international conference on high energy physics, Glasgow (United Kingdom), 21-27 Jul 1994). Order Number DE95003929. Source: OSTI; NTIS; INIS; GPO Dep.

We have searched for production of $t\bar{t}$ pairs in $p\bar{p}$ interactions at 1.8 TeV center-of-mass energy at the FNAL Tevatron collider. The search assumes standard model decay for top quark into W + b quark. We observe in μ + jets and 14 + jets final states a small, not statistically significant, excess above the background estimated by two different methods. The results presented are preliminary.

6751 (BNL–61012) **Introduction to the physics of Higgs bosons.** Dawson, S. Brookhaven National Lab., Upton, NY (United States). Nov 1994. 60p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. (CONF-9405267–1: 1994 Theoretical Advanced Study Institute conference, Boulder, CO (United States), 30 May - 23 jun 1994). Order Number DE95003965. Source: OSTI; NTIS; INIS; GPO Dep.

A basic introduction to the physics of the Standard Model Higgs boson is given. We discuss Higgs boson production in e^+e^- and hadronic collisions and survey search techniques at future accelerators. The Higgs bosons of the minimal SUSY model are briefly considered. Indirect limits from triviality arguments, vacuum stability and precision measurements at LEP are also presented.

6752 (FNAL/C–93/334-E) **W mass measurements from DØ and CDF experiments at TeVatron.** Jung, Chang Kee (State Univ. of New York, Stony Brook, NY (United States)). Fermi National Accelerator Lab., Batavia, IL (United States). Oct 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940722–34: 27. international conference on high energy physics, Glasgow (United Kingdom), 21-27 Jul 1994). Order Number DE95003497. Source: OSTI; NTIS; INIS; GPO Dep.

The authors present preliminary measurements of the W boson mass made by the D0 and CDF experiments using data collected at the Fermilab TeVatron $\bar{p}p$ collider operating at $\sqrt{s}$ = 1.8 TeV. The result from the CDF $W \rightarrow e\nu$ data analysis is $M_W = 80.47 \pm 0.15(stat) \pm 0.25(sys)$ GeV/c^2 and the result from the CDF $W \rightarrow \mu\nu$ data analysis is $M_W = 80.29 \pm 0.20(stat) \pm 0.24(sys)$ GeV/c^2. The result from the D0 $W \rightarrow e\nu$ data analysis is $M_W = 79.86 \pm 0.16(stat) \pm 0.31(sys)$ GeV/c^2. When combined with the previous measurements, these results yield a world average value of M_W, 80.23 ± 0.18 GeV/c^2.

6753 (FNAL/C–94/282-E) **A measurement of the mass of the W vector boson at CDF.** Keup, R.M. (Illinois Univ., Urbana, IL (United States). Dept. of Physics). CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940816–58: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95003498. Source: OSTI; NTIS; INIS; GPO Dep.

We present a preliminary measurement of the mass of the W vector boson using the decays $W \rightarrow ev$ and $W \rightarrow \mu\nu$. The mass of the W is an important parameter of the standard model. Through its relation to both the top quark and the higgs sector, it provides a sensitive probe of the electroweak theory. During the last run of Fermilab's Tevatron, CDF recorded $\bar{p}p$ collisions at $\sqrt{s}$ = 1.8 TeV corresponding to an integrated luminosity of 19.3 pb^{-1}. An analysis of both decay channels yields a combined mass measurement of Mw = 80.38 ± 0.23 GeV/c.

6754 (FNAL/C–94/328-E) **Measurement of correlated b quark cross sections at CDF.** Gerdes, D. CDF Collaboration. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);Ministry of Education, Science and Culture (Japan);Natural Sciences and Engineering Research Council of Canada, Ottawa, ON (Canada);Istituto Naz DOE Contract AC02-76CH03000. (CONF-940816–67: Meeting of the Division of Particles and Fields of the American Physical Society, Albuquerque, NM (United States), 2-6 Aug 1994). Order Number DE95004240. Source: OSTI; NTIS; INIS; GPO Dep.

Using data collected during the 1992–93 collider run at Fermilab, CDF has made measurements of correlated b quark cross section where one b is detected from a muon from semileptonic decay and the second b is detected with secondary vertex techniques. We report on measurements of the cross section as a function of the momentum of the second b and as a function of the azimuthal separation of the two b quarks, for transverse momentum of the initial b quark greater than 15 GeV. Results are compared to QCD predictions.

6755 (FNAL/C–94/331-E) **Search for supersymmetry and leptoquark states at FNAL.** Hagopian, S. (Florida State Univ., Tallahassee, FL (United States). Dept. of Physics). Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940722–32: 27. international conference on high energy physics, Glasgow (United Kingdom), 21-27 Jul 1994). Order Number DE95003381. Source: OSTI; NTIS; INIS; GPO Dep.

Searches have been made for first generation scalar and vector leptoquarks by the D0 collaboration and for second generation scalar leptoquarks by the CDF collaboration. The data sample is from the 1992-93 $p\bar{p}$ run at $\sqrt{s}$ = 1.8 TeV at the Fermilab Tevatron Collider. Assuming that leptoquarks are pair produced and decay into charged leptons and quarks with branching fraction β, mass limits at the 95% Confidence Level (CL) have been obtained. For first generation scalar leptoquarks the lower mass limit is 130 GeV/c^2 for β = 1.0 and 116 GeV/c^2 for β = 0.5. For first generation vector leptoquarks with κ, the anomalous coupling, of 1.0 and β = 1.0, the lower mass limit is 240 GeV/c^2 and for κ = 1.0, β = 0.5, the lower mass limit is 240 GeV/c^2. For κ = 0 and β = 1.0, the lower mass limits is 190 GeV/c^2 and for κ = 0, β = 0.5, the lower mass limit is 185 GeV/c^2. For second generation scalar leptoquarks, the mass limits are 133 GeV/c^2 for β = 1.0 and 98 GeV/c^2 for β = 0.5. A search for squarks and gluinos, predicted by Supersymmetric models, was made by D0 in the three or more jets plus E_t channel. The number of events observed was consistent with background. For heavy squarks, a lower gluino mass limit of 146 GeV/c^2 was obtained, and for equal squark and gluino masses a mass limit of 205 GeV/c^2 was obtained at the 95% CL.

6756 (FNAL/C–94/339-E) **Evidence for top quark production in 1.8 TeV $\bar{p}p$ collisions.** Jensen, H.B. Fermi National Accelerator Lab., Batavia, IL (United States). Sep 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH03000. (CONF-940722–33: 27. international conference on high energy physics, Glasgow (United Kingdom), 21-27 Jul 1994). Order Number DE95003496. Source: OSTI; NTIS; INIS; GPO Dep.

This report is a summary of the evidence for top quark production in $\bar{p}p$ collisions at a center of mass energy of 1.8 TeV which was obtained by the CDF Collaboration earlier this year. The data analyzed corresponds to an integrated luminosity of 19.3 pb^{-1}, recorded with the CDF Detector at the Fermilab Tevatron Collider during 1992-1993. Three different search channels for $t\bar{t}$ production are used. A search for dilepton events finds 2 events, while two different methods of identifying b-quark jets in events with $W+ \geq 3$ jets finds 6 and 7 events, respectively. The probability that the observed total yield is consistent with the estimated background of $5.96_{-0.44}{}^{+0.49}$ is 0.26%. Though the statistics are too limited to firmly establish the existence of the top quark, a natural interpretation of the excess is that it is due to $t\bar{t}$ production. Under this assumption, constrained mass fitting of a subset of events yields a top quark mass of $174 \pm 10_{-12}{}^{+13}$ GeV/c^2 and a $t\bar{t}$ production cross section of $13.9_{-4.8}{}^{+6.1}$ pb.

6757 (INIS-RU–379, pp. 55-57) **Photoproduction of a hypothetic neutral particle in oriented monocrystal.** Kunashenko, Yu.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The production of X^0 particles by high energy photons in oriented monocrystals is discussed as a means of particle detection. Particle production in continous potentials of crystallographic axices or planes and coherent photoproduction are considered. The calculations showed 10^{-3} photon yield from 1 cm Ge monocrystal. 9 refs.

6758 (SLAC-PUB–6620) **Spin structure of the nucleon and polarization.** Prescott, C.Y. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Sep 1994. 4p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-940693–5: Conference on physics in collision, Tallahassee, FL (United States), 15-17 Jun 1994). Order Number DE95004282. Source: OSTI; NTIS; INIS; GPO Dep.

Recent experiments at CERN and SLAC have added new knowledge about the spin structure of the proton and the deuteron. A brief historical background is presented, the status of experiments is discussed, and progress in the understanding of the spin of the nucleon in the context of the quark parton model is summarized.

6630 Nuclear Physics

6759 (INIS-mf–14421) **Nuclear physics, neutron physics and nuclear energy. Proceedings.** Andrejtscheff, W.; Elenkov, D. (eds.). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

The book contains of proceedings of XI International School on Nuclear Physics, Neutron Physics and Nuclear Energy organized traditionally every two years by Bulgarian Academy of Sciences and the Physics Department of Sofia University held near the city of Varna. It provides a good insight to the large range of theoretical and experimental results, prospects, problems, difficulties and challenges which are at the core of nuclear physics today. The efforts and achievements of scientists to search for new phenomena in nuclei at extreme circumstances as .superdeformation and band crossing in nuclear structure understanding are widely covered. From this point of view the achievements and future in the field of high-precision γ-spectroscopy are included. Nuclear structure models and methods, models for strong interaction, particle production and properties, resonance theory and its application in reactor physics are comprised also. (V.T.).

6631 Nuclear Structure

Refer also to citation(s) 6432

6760 (DOE/ER/40270–55) **Investigations of the structure and electromagnetic interactions of few-body systems. Progress report, 1 July 1991–30 June 1994.** Lehman, D.R.; Haberzettl, H.; Maximon, L.C.; Parke, W.C.; Bennhold, C.; Ito, Hiroshi; Pratt, R.K.; Najmeddine, M.; Rakei, A. George Washington Univ., Washington, DC (United States). Center for Nuclear Studies. Jul 1994. 71p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-86ER40270. Order Number DE95004377. Source: OSTI; NTIS; INIS; GPO Dep.

In order to make it easy for the reader to see the specific research carried out and the progress made, the following report of progress is done by topic. Each item has a format layout of Topic, Investigators, Objective, Significance, and Description of Progress, followed at the end by the relevant references. As is clear from the topics listed, the emphasis of the GW nuclear theory group has been on the structure and electromagnetic interactions of few-body nuclei. Both low- and intermediate-energy electromagnetic disintegration of these nuclei is considered, including coherent photoproduction of π mesons. When the excitation energy of the target nucleus is low, the aim has been to handle the continuum part of the theoretical work numerically with no approximations, that is, by means of full three- or four-body dynamics. When structure questions are the issue, numerically accurate calculations are always carried through, limited only by the underlying two-body or three-body interactions used as input. Implicit in our work is the question of how far one can go within the traditional nuclear physics framework i.e., nucleons and mesons in a nonrelativistic setting. Our central goal is to carry through state-of-the-art few-body calculations that will serve as a means of determining at what point standard nuclear physics requires introduction of relativity and/or quark degrees of freedom in order to understand the phenomena in question. So far, the problems considered were mostly concerned with low- to medium-energy regimes where little evidence was found that requires going beyond the traditional approach.

6761 (DOE/ER/40314–8) **Research in nuclear physics: Progress report, June 1, 1993–July 31, 1994.** Kozub, R.L.; Hindi, M.M. Tennessee Technological Univ., Cookeville, TN (United States). Dept. of Physics. Aug 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-87ER40314. Order Number DE95003701. Source: OSTI; NTIS; INIS; GPO Dep.

The main emphasis of the program are studies of the structure of neutron-rich nuclei and rare electron capture processes. Research topics discussed are: (1) search for a 17 keV neutrino in internal bremsstrahlung spectrum of ^{125}I; (2) absolute intensity of internal bremsstrahlung for the EC decay of ^{125}I; (3) internal bremsstrahlung endpoint of ^{109}Cd; (4) search for massive neutrinos in the recoil spectrum of ^{37}Cl following electron capture decay of ^{37}Ar; (5) the Auger relaxation of ^{37}Cl following electron capture decay of ^{37}Ar; and (6) neutralization of ions after neutrino-induced desorption.

6762 (INIS-mf–14421, pp. 46-69) **Nuclear structure of light rare-earths and light actinides at low excitation energy.** Gizon, A. (Institut des Sciences Nucleaires, IN2P3/CNRS - Universite Joseph Fourier, Grenoble Cedex (France)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

The goal of this work is to establish detailed level schemes fed in a β-decay chain to identify new possible positive-parity Nilsson bands, to establish low-lying state systematics and extract deformation parameters. At the frontier of the light actinide region the existence of an octupole deformation at very low excitation energy as theoretically predicted has been experimentally searched. The neutron-deficient isotopes studied have been produced by fusion evaporation reactions induced by medium or heavy ions projectiles at 5-7 MeV/nucleon energies on thin metallic targets. On-line mass separation and He-jet techniques have been used at the SARA accelerator. ^{96}Mo+^{40}Ca system at 255 MeV has been used to produce ^{131}Nd, ^{131} Pr and search for a ^{131m}Pr isomeric state. The ^{131}Nd→^{131}Pr→^{131}Ce radioactive decay chain is studied. The ^{131}Ce level scheme observed in the ^{131m,g}Pr decay is proposed. The ^{129}Nd→^{129}Pr→^{129}Ce poorly known radioactive decay chain is investigated. To produce Nd and Pr activities the ^{94}Mo + ^{40}Ca system at 255 MeV has been used. On this basis the ^{129}Ce level scheme observed in the ^{129}Pr β^+ decay is proposed. The low-lying state systematics in odd-A Ce isotopes and the systematics of low-energy positive parity sates observed in odd-A $^{129-135}$Pr are established. The ^{2}23Th isotope has been produced by fusion reaction ^{208} Pb + ^{18}O at 82 MeV. A new level scheme is proposed for ^{219} Ra populated in the ^{223} Th decay at low energy including a tentative correlation between alpha decay studies and in beam results. The ^{215}Rn nucleus has been studied in the alpha decay of ^{219}Rn in secular equilibrium with ^{223}Th (T1/2=0.66s) as a by-product in the preceding measurements and the level structure of ^{215} Rn is constructed. 16 figs., 1 tab., 43 refs. (orig.).

6763 (INIS-mf–14421, pp. 94-111) **Global systematics of band structures and symmetries in even-even nuclei.** Bucurescu, D. (Institutul de Fizica Atomica, Bucharest (Romania)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

It is shown that systematics of the type evidenced by Mallmann for the quasiground band are obeyed by energy ratios within other bands as well. Correlations between different energy ratios are studied by using their associated 'symmetry triangle', which can be used both to find other universal systematics and to characterize the evolution of the nuclear collectivity with respect to the basic dynamical symmetries. Finally, the nearly universal anharmonic vibrator description of the quasiground band in the non-deformed

collective nuclei is extended to non-yrast states, its transition towards the rotor behaviour having the character of a critical phase transition. 14 refs. (orig.).

6764 (INIS-mf–14421, pp. 112-135) **Nuclear structure by laser spectroscopy.** Anastassov, A. (Joint Inst. for Nuclear Research, Dubna (Russian Federation)); Gangrski, Yu.; Markov, B.; Zemlyanoj, S.; Marinova, K.; Nadzhakov, E.; Kul'dzhanov, B. Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

This paper illustrates the contribution of laser spectroscopy to authors knowledge about nuclear structure properties, in particular about variations of nuclear charge radii in long isotopic and isotonic chains comprising stable and short lived isotopes. The experiments are performed at Flerov Laboratory of Nuclear Reactions (FLNR), JINR. The changes in the mean square (ms) charge radii and nuclear moments are measured for two nuclei: $_{72}$Hf with average neutron number of about 107 which is located closely beyond the well investigated rare earths in the very interesting mass region of strongly deformed nuclei; and $_{22}$Ti, the stable isotopes of which lie within the very interesting shell $20 \leq N, Z \leq 28$ which is just in the Z region with a large lack of optical information on nuclear properties. All stable hafnium isotopes and its long living isotope ^{182}Hf ($T1/2=9\times10^{6}$ years) have been investigated. The optical and muonic data predict different behaviour of the nuclear deformation in the Hf mass region investigated. The changes of ms nuclear charge radii of Ti stable isotopes extracted from optical IS are reported for the first time. On the basis of investigation it is concluded that the charge radius variation is very sensitive to the model predictions and can serve as a probe for model validity. The most conspisuous feature of the nuclear charge radius is the strong deviation from the prediction of the spherical droplet model requiring the inclusion of different multipolarity deformation effects. An extension of the droplet model includes deformation effects using theoretical results on nuclear deformation, for example third order of quadrupole deformation, which discriminates between prolate and oblate shape or a generalization which includes thriaxial shape. The predictions on this basis are affected by corresponding uncertainties but in general in many cases even for long isotopic chains, an impressive coincidence is achieved.

6765 (INIS-mf–14421, pp. 135-152) **Baryon mapping of quark systems.** Pittel, S. (Delaware Univ., Newark, DE (United States). Bartol Research Inst.); Arias, J.; Dukelsky, J.; Frank, A. Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

A colorless baryon mapping of three-quark clusters, specifically tailored to physical constituent quark models in which Hamiltonian may contain up to three-quark interactions and is a color scalar are presented. It is tested in the context of a three color extension of the Lipkin model. It is found that the mapping exactly reproduces (within its physical subspace) the full spectrum of states of the original quark model. Furthermore, when the mapping is implemented in its nonhermitian version, the unphysical states (those that are pure artefact of the mapping and have no physical relevance) are pushed up in energy. Despite the very promising results of these test calculations, there is still more to do before concluding that the mapping can be used to derive nuclei from real constituent quark models as is the authors ultimate goal. There are two additional tests which have to be performed, successfully and then turn to study of real nuclei. The authors main goal was to see to what extent traditional nuclear physics can be described directly from quarks. 2 figs., 10 refs. (orig.).

6766 (INIS-mf–15050) **Gamma-ray spectroscopy for investigation of the co-existence of deformed and spherical states in the magic nucleus of ^{114}Sn.** Schimmer, M. Koeln Univ. (Germany). Mathematisch-Naturwissenschaftliche Fakultaet. 5 May 1993. 150p. (In German). Order Number DE95726936. Source: OSTI; NTIS (US Sales Only); INIS.

The term diagram of the $_{50}{}^{114}Sn_{64}$ magic nucleus could be enlarged by 77 newly identified gamma transitions and 47 novel energy levels identified by way of a gamma-gamma coincidence measurement using the OSIRIS hexahedral spectrometer and by means of the high-spin reaction of $^{100}Mo(^{18}O,4n)^{114}Sn$ at an injection energy of $E(^{18}O) = 70$ MeV. Spins up to an excitation energy of $\propto$ 11.2 MeV and up to a maximum spin of 23 h have been occupied. For identification of the multipolarities of low-intensity γ-transitions which deplete the high-spin states, $\gamma\gamma$-angular correlations have been evaluated, and 26 energy levels could be clearly assigned for the first time to measured spin values. For an interpretation of further nuclear structural states of ^{114}Sn theoretical calculation have been made based on the shell model of nucleus. (orig./DG)

6767 (INS–1068) **The meaning of Dirac's large number hypothesis.** Terazawa, Hidezumi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Oct 1994. 10p. Order Number DE95737280. Source: OSTI; NTIS; INIS.

Dirac's large number hypothesis (LNH) states that the Eddington large numbers $N_1(\equiv\alpha/Gm_em_p\simeq10^{39})$, $N_2(\equiv m_e/\alpha H\simeq10^{40})$ and $N_3(\equiv4\pi\rho/3m_pH^3\simeq10^{80})$ are not independent but related with each other. By reconsidering the meaning of the LNH, it is shown that not only the 'dynamical' LNH relation of N_3-N_1N_2 but also the 'geometrical' LNH relation of N_3-$(N_2)^2$ holds so that the LNH may not be taken as a hypothesis but become the large number rule (LNR). (author).

6768 (LA-UR–94-2132) **Few-body physics: Then and now.** Friar, J.L. Los Alamos National Lab., NM (United States). [1994]. 18p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9405132–5: 14. international conference on few body problems in physics, Williamsburg, VA (United States), 26-31 May 1994). Order Number DE94014418. Source: OSTI; NTIS; INIS; GPO Dep.

This review describes past progress in selected topics of few-body nuclear physics, as well as calculations and experiments that the author believes necessary for further orderly progress. Review also gives specific data on binding energies and nuclear radii. 36 references.

6769 (LBL–36165) **Is there evidence for a liquid-gas phase transition in nuclear matter?.** Hirsch, A.S. (Purdue Univ., West Lafayette, IN (United States). Dept. of Physics). EOS Collaboration. Lawrence Berkeley Lab., CA (United States). Sep 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9409242–2: CORINNE 2: international conference on multiparticles correlation and particle production in nucleus-nucleus collisions, Nantes (France), 5-9 Sep 1994). Order Number DE95003418. Source: OSTI; NTIS; INIS; GPO Dep.

The multifragmentation of gold nuclei at 1 GeV/nucleon has been studied using reverse kinematics. The moments of the resulting charged fragment distribution have been analyzed using methods borrowed from percolation theory. These moments provide clear evidence for critical behavior occurring in a system of about 200 nucleons. The critical exponents extracted from the data are close to those of liquid-gas systems.

6770 (LBL–36206) **Excitation of a quantal and a classical gas in a time-dependent potential.** Blocki, J. (Inst. for Nuclear Studies, Otwock-Swierk (Poland)); Brut, F.; Skalski, J.; Swiatecki, W.J. Lawrence Berkeley Lab., CA (United States). 28 Sep 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9408180–2: 4. KINR international school on nuclear physics, Kiev (Russian Federation), 29 Aug - 7 sep 1994). Order Number DE95003426. Source: OSTI; NTIS; INIS; GPO Dep.

We report on computer simulations of oscillating Woods-Saxon or cavity potentials filled with either a classical or a quantal gas of independent particles. We have now available of the order of 600 excitation histories of such gases undergoing usually one period of

oscillation (but sometimes several), classified according to frequency and multipolarity of the oscillation and of the degree of diffuseness of the potential. We are still in the process of displaying and interpreting some of the results, but certain important features are already apparent. A notable finding is that, contrary to concerns sometimes voiced in the literature, the classical wall formula does not fail catastrophically when confronted with quantal calculations. This is true even for relatively small systems – in our case 112 neutrons in doubly degenerate eigenstates. On the contrary, the wall formula, in addition to reproducing accurately the classical computer simulations, gives also an approximate account of the quantal results in the regime where it is expected to be valid, namely for not too small oscillation frequencies and not too large surface diffuseness. In those cases it is gratifying to observe that the deviations from the wall formula actually correlate (semiquantitatively) with the wave-mechanical corrections derived by Koonin et al.

6771 (SLAC-PUB–6729) **The impact of QCD and light-cone quantum mechanics on nuclear physics.** Brodsky, S.J. (Stanford Linear Accelerator Center, Menlo Park, CA (United States)); Schlumpf, F. Stanford Linear Accelerator Center, Menlo Park, CA (United States). Dec 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00515. (CONF-9409259–1: Electromagnetic probes and the structure of hadrons and nuclei, Erice (Italy), 15-23 Sep 1994). Order Number DE95004293. Source: OSTI; NTIS; INIS; GPO Dep.

We discuss a number of novel applications of Quantum Chromodynamics to nuclear structure and dynamics, such as the reduced amplitude formalism for exclusive nuclear amplitudes. We particularly emphasize the importance of light-cone Hamiltonian and Fock State methods as a tool for describing the wavefunctions of composite relativistic many-body systems and their interactions. We also show that the use of covariant kinematics leads to nontrivial corrections to the standard formulae for the axial, magnetic, and quadrupole moments of nucleons and nuclei.

6632 Radioactivity and Electromagnetic Transitions (Excluding Fission)

Refer also to citation(s) 6761, 6762

6772 (INIS-mf–14421, pp. 1-27) **Superdeformed bands in the A≈130 region.** Gizon, J. (Institut des Sciences Nucleaires, IN2P3/CNRS - Universite Joseph Fourier, Grenoble Cedex (France)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

Discovery, some typical features, origin, population and deexcitation of superdeformed bands (SD) are briefly reviewed. The last generation arrays are designed to study very weak amplitudes phenomena and they must have a large efficiency and large resolving power. Compared to the previous γ-ray spectrometers the new generation (EUROGAM and GASP already operating, GAMMASPHERE under construction, EUROBALL and TRIGAMM project) is characterized by a much greater number of Ge detectors and a total peak efficiency 10 or 20 times larger. The main characteristics of the new arrays: EUROGAM and GASP are given. The first observation of the SD bands in the 130 mass region based on two experiments is reported. The first nucleus studied is ^{132}Ce produced in the ^{100}Mo(^{36}S,4n) reaction at 155 MeV. The γ-rays were detected by 42 Ge detectors of EUROGAM 1. Two excited SD bands have been identified in ^{132}Ce. The first one is composed of 13 transitions of energies between 794 and 1687 KeV and another of 12 transitions between 947 and 1725 KeV. Another experiment has been performed using EUROGAM to search for excited SD bands in ^{133}Pr produced by reaction ^{100}Mo(^{37}Cl,4n) at 155 MeV. Four SD bands have been discovered in ^{133}Pr with transitions ranging from 0.8 to 1.6 MeV. The observation of identical SD bands in Ce and Pr isotopes and the decay out of the yrast SD bands in ^{133}Nd and ^{135}Nd are discussed. The new projects on other arrays of the third generation as EUROBALL, GAMMASPHERE, TRIGAM are briefly reviewed. It is emphasized that the use of new arrays will give the possibility to observe weaker amplitude phenomena like the hyperdeformation also predicted in the mass 130 region. 21 figs., 46 refs.(orig.).

6773 (INIS-mf–14421, pp. 152-175) **Euroball III, a European γ-ray facility and superdeformation in Gd nuclei around A=146.** Lieder, R. (Kernforschungsanlage Juelich GmbH (Germany)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

Summarized are the main lines of investigations of new phenomena in nuclei under extreme circumstances close to the limit of stability for which the excitation energy, the angular momentum or the ratio of protons to neutrons take extreme values. It is emphasized that the most powerful means to carry out such experiments is the high precision γ-ray spectroscopy. Discussed are the main features of γ-ray detectors which have to be optimized as a photopeak efficiency, peak/total ratio, energy resolution, isolated hit probability. The Nordball spectrometer in the study of the superdeformed band in ^{143}Eu is described. The Euroball project and the γ-detector array Euroball III to be used in the project experiments are discussed. The main advantages of Cluster detector, encapsulated Ge detector and BGO escape-suppression detector are outlined. To search for superdeformation in ^{144}Gd an experiment at the γ-spectrometer GASP has been performed using the reaction ^{100}Mo(^{48}Ti,4n) at a beam energy 221 MeV. Using the Radford package, 14 coincident transition are identified and a double-gated coincidence spectrum of the resulting superdeformed band is obtained. The intensity of the superdeformed band was estimated to be ≈0.2% of the total population of the nucleus ^{144}Gd. The weak population of the superdeformed band in ^{144}Gd explain why it is not possible to detect it in the previous experiments. The three close lying transitions at ≈ 890 KeV indicate that the superdeformed band in ^{144} Gd undergoes a band crossing at a rotational frequency of $\hbar\omega$=0.45 MeV. This is the first experimental observation of a crossing in a superdeformed band related to the alignment of a proton pair. An open question is the small intensity of the superdeformed band in ^{144} Gd. 14 figs., 36 refs. (orig.).

6633 Nuclear Reactions and Scattering, General

Refer also to citation(s) 6771

6634 Specific Nuclear Reactions and Scattering

Refer also to citation(s) 6432, 6693, 6694, 6699, 6701, 6705, 6706, 6707, 6738, 6739, 6746, 6760

6774 (ANL/PHY/CP–84791) **Recent results from APEX.** Ahmad, I. (Argonne National Lab., IL (United States). Physics Div.); Back, B.B.; Austin, S.M. Argonne National Lab., IL (United States). Physics Div. [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940888–1: Physics with large gamma ray decector arrays conference, Berkley, CA (United States), 2-6 Aug 1994). Order Number DE95004122. Source: OSTI; NTIS; INIS; GPO Dep.

The focus of the APEX project is the study of the emission of electrons and positrons from collisions of heavy ions. However, scattering of this type involves intense Coulomb excitation of nuclear states so nuclear spectroscopy can never be far from one's mind. The authors also have close connections with the conference title; the detector which they describe does contain two large gamma arrays, each subtending 58% of 4π and containing 24 position sensitive detectors. Finally, they will see their research may have uncovered some interesting new spectroscopy in the actinides, so the connections between APEX and this conference may be closer than is first apparent.

6775 (BNL–61005) **Sum rule measurements of the spin-dependent compton amplitude (nucleon spin structure at Q^2 = 0).** Babusci, D. (Laboratori Nationali di Frascati-INFN, Rome (Italy)); Giordano, G.; Baghaei, H.; Cichocki, A.; Blecher, M.; Breuer, M.; Commeaux, C.; Didelez, J.P.; Caracappa, A.; Fan, Q. Brookhaven National Lab., Upton, NY (United States). [1995]. 43p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Order Number DE95003947. Source: OSTI; NTIS; INIS; GPO Dep.

Energy weighted integrals of the difference in helicity-dependent photo-production cross sections ($\sigma_{\frac{1}{2}} - \sigma_{3/2}$) provide information on the nucleon's Spin-dependent Polarizability (γ), and on the spin-dependent part of the asymptotic forward Compton amplitude through the Drell-Hearn-Gerasimov (DHG) sum rule. (The latter forms the Q^2=0 limit of recent spin-asymmetry experiments in deep-inelastic lepton-scattering.) There are no direct measurements of $\sigma_{\frac{1}{2}}$ or $\sigma_{3/2}$, for either the proton or the neutron. Estimates from current π-photo-production multipole analyses, particularly for the proton-neutron difference, are in good agreement with relativistic-I-loop Chiral calculations (χPT) for γ but predict large deviations from the DHG sum rule. Either (a) both the 2-loop corrections to the Spin-Polarizability are large and the existing multipoles are wrong, or (b) modifications to the Drell-Hearn-Gerasimov sum rule are required to fully describe the isospin structure of the nucleon. The helicity-dependent photo-reaction amplitudes, for both the proton and the neutron, will be measured at LEGS from pion-threshold to 470 MeV. In these double-polarization experiments, circularly polarized photons from LEGS will be used with SPHICE, a new frozen-spin target consisting of $\vec{H} \cdot \vec{D}$ in the solid phase. Reaction channels will be identified in SASY, a large detector array covering about 80% of 4π. A high degree of symmetry in both target and detector will be used to minimize systematic uncertainties.

6776 (DOE/ER/40561–167) **Anisotropy of dilepton emission from nuclear collisions.** Bratkovskaya, E.L. (Joint Inst. for Nuclear Research, Dubna (Russian Federation). Bogolubov Lab. of Theoretical Physics); Teryaev, O.V.; Toneev, V.D. Washington Univ., Seattle, WA (United States). Inst. for Nuclear Theory. 7 Nov 1994. 11p. Sponsored by USDOE, Washington, DC (United States);International Science Foundation. DOE Contract FG06-90ER40561. Grant N0 MP8000. Order Number DE95004354. Source: OSTI; NTIS; INIS; GPO Dep.

Attention is paid to studying the angular characteristics of e^+e^- pairs created in collisions with nuclear targets at intermediate and relativistic energies. Arising due to general spin and angular momentum constraints, the dilepton anisotropy seems to be quite sensitive to the contribution of different sources and may be used for disentangling these sources (or models) as well as an additional signature of a possible chiral symmetry restoration and phase transition of hadrons into the quark-gluon plasma. An anisotropy estimate for some dilepton sources is given and its relevance to the problems mentioned is discussed.

6777 (DOE/ER/40561–169) **Nuclear multifragmentation critical exponents.** Bauer, W. (Washington Univ., Seattle, WA (United States). Inst. for Nuclear Theory); Friedman, W.A. Washington Univ., Seattle, WA (United States). Inst. for Nuclear Theory. [1995]. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-90ER40561. Order Number DE95004356. Source: OSTI; NTIS; INIS; GPO Dep.

In a recent Letter, cited in a reference, the EoS collaboration presented data of fragmentation of 1 A GeV gold nuclei incident on carbon. By analyzing moments of the fragment charge distribution, the authors claim to determine the values of the critical exponents γ, β, and τ for finite nuclei. These data represent a crucial step forward in the understanding of the physics of nuclear fragmentation. However, as shown in this paper, the analysis presented in the cited reference is not sufficient to support the claim that the critical exponents for nuclear fragmentation have been unambiguously determined.

6778 (DOE/ER/40764–3) **Theory of ultra dense matter and the dynamics of high energy interactions involving nuclei. Progress report, December 15, 1993–December 14, 1994.** Gyulassy, M. Columbia Univ., New York, NY (United States). 12 Sep 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-93ER40764. Order Number DE95004114. Source: OSTI; NTIS; INIS; GPO Dep.

This report summarizes the progress made during the second year of the three year DOE agreement DE-FG02-93ER40764 on theoretical nuclear physics research performed at the Columbia University and presents a detailed budget adjustment for the third year period December 15, 1994 to December 14, 1995. Sections 1.1 to 1.8 highlight the technical progress made on the following general areas: Multiple scattering and radiative processes in QCD; the quark-gluon plasma transition in nuclear matter; QCD transport theory and dissipative mechanism in dense matter; phenomenological models of high energy interactions involving nuclei; signatures of quark-gluon plasma formation in A+A; neurocomputation theory. Section 2 contains a bibliography of published papers and invited conference papers. Section 3 lists the Columbia nuclear theory members for the December 15, 1994 to December 14, 1995 period. Finally, the budget adjustment requesting $319,830 for the third year relative to the original $320,000 is presented in section 6. Copies of the research papers accompany this report.

6779 (INIS-mf–14421, pp. 38-45) **Near-threshold π^0-production on ^{24}Mg with ^{4}He of 43 and ^{16}O of 24 and 33 MeV·A.** Ernst, J. (Bonn Univ. (Germany). Inst. fuer Strahlen- und Kernphysik). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

The near-threshold π^0-production on ^{24}Mg with ^{4}He of 43 and ^{16}O of 24 and 33 MeV·A was studied with a lead glass shower detector. The cross sections of 3.5 nb and 6.6. nb from the ^{16}O induced reactions are compatible with other experiments. For the α-induced reaction a sizable yield of 1.3 nb was found, only 22 MeV above the absolute threshold and far below the Δ-resonance. The differential cross sections at very backward angles are by an order of magnitude bigger than those at 90° indicating the π^0's being produced at the front end of the larger target nucleus. 5 figs., 2 tabs., 10 refs. (orig.).

6780 (INIS-mf–14421, pp. 80-93) **Antiproton annihilation at rest.** Machner, H. (Forschungszentrum Juelich GmbH (Germany)). Bylgarska Akademiya na Naukite, Sofia (Bulgaria). Inst. za Yadrena Izsledvaniya i Yadrena Energetika; Sofia Univ. (Bulgaria). Katedra po Atomna Fizika. 1994. 241p. (CONF-9310392–: 11. international school on nuclear physics, neutron physics and nuclear energy, Varna (Bulgaria), 4-11 Oct 1993). In *Nuclear physics, neutron physics and nuclear energy. Proceedings.* Order Number DE95611127. Source: OSTI; NTIS (US Sales Only); INIS.

Antiproton annihilation at rest with nuclei mainly uranium has been investigated by studying energy spectra, mass distributions of residual nuclei with activation techniques and correlation measurements of fragments with a fission fragment spectrometer. These studies gave insights in the reaction process which has several steps occuring on different time scales. The residual nucleus distribution from a ^{238}U target shows that both symmetric and asymmetric fission take place. Detection and analysis of coincident ^{209}Bi, ^{232}Th and ^{238}U enabled us to determine the individual and total mass distributions of the fragments, their opening angle, the average excitation energy and momentum of the nucleus at scission, and the number of nucleons emitted before and after scission. We have found that the process is asymmetric for low excitation energies and symmetric for higher ones. INC calculations have reproduced the experimental results. 15 figs., 2 tabs., 35 refs. (orig.).

6781 (INS–1067) **Evidence of central repulsion potential from pionic decay of s-shell Λ-hypernuclei.** Kumagai-Fuse, I. (Hokkaido Univ., Sapporo (Japan). Dept. of Physics); Okabe, S.; Akaishi, Y. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Oct 1994. 12p. Order Number DE95737279. Source: OSTI; NTIS; INIS.

Pionic decays of A=4 and 5 hypernuclei are discussed to obtain information about a nucleus-Λ potential. Results for the available decay widths support as a whole that the nucleus-Λ potential has central repulsion not only in A=5 but also in A=4 hypernuclei. (author).

6782 (JAERI-M–94-019, pp. 28-36) **Recent nuclear data activities in China related to CENDL-2.** Zhao Zhixiang (Chinese Nuclear Data Center, Beijing, BJ (China)); Zhang Jingshang. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

Recent nuclear data activities in China related to CENDL-2 is summarized in this presentation. (author).

6783 (JAERI-M–94-019, pp. 171-178) **Measurements of thermal neutron cross section and resonance integral for the ^{237}Np(n,γ)^{238}Np reaction.** Kobayashi, Katsuhei (Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst.); Yamanaka, Akihiro; Kimura, Itsuro. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

Making use of a standard neutron spectrum field with a pure Maxwellian distribution at the heavy water thermal neutron facility of the Kyoto University Reactor (KUR), thermal neutron cross section for the ^{237}Np(n,γ)^{238}Np reaction was measured by the activation method, using a high purity Ge detector. The result is 158±3b, which is obtained relative to the reference value of 98.65±0.09b for the ^{197}Au(n,γ)^{198}Au reaction. The present value is lower by about 7% than that with the ENDF/B-V data. The data given by Mughabghab and obtained from JENDL-3 are larger by 11 to 15% than the present measurement. The resonance integral for the ^{237}Np(n,γ)^{238}Np reaction was measured with a 1/E standard neutron spectrum in the cavity of the central graphite reflector region between the two-divided cores of the Kinki University Reactor (UTR-KINKI), relative to the reference value of 1550±28b for the ^{197}Au(n,γ)^{198}Au reaction. By defining the Cd cut-off energy as 0.5eV, present resonance integral is 652±24b, which is in good agreement with the JENDL-3, ENDF/B-V and Mughabghab data. However, most of the old experimental data are, in general, larger by 24 to 38% than the present measurement. (author).

6784 (JAERI-M–94-068, pp. 14-25) **Processing of covariance file and related problems.** Hasegawa, Akira (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1994. (CONF-9307182–: Specialists' meeting on covariance data, Tokai (Japan), 15-16 Jul 1993; INDC(JPN)–171/U). In *Proceedings of the specialists' meeting on covariance data.* 95p. Order Number DE94013048. Source: OSTI; NTIS; INIS.

Processing methods for generating broad group covariance data from ENDF/B format data are described briefly. Outline of covariance file, FORMAT, available processing codes, and processed data generally available are also described. Encountered problems from the processing of ENDF/B files are reviewed. Comments on the compilation strategy for JENDL covariance file, which is in scheduled, are made. (author).

6785 (JAERI-M–94-068, pp. 26-28) **Experience on preparation of a covariance library for the NEUPAC code.** Iguchi, T. (Tokyo Univ. (Japan). Faculty of Engineering). Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1994. (CONF-9307182–: Specialists' meeting on covariance data, Tokai (Japan), 15-16 Jul 1993; INDC(JPN)–171/U). In *Proceedings of the specialists' meeting on covariance data.* 95p. Order Number DE94013048. Source: OSTI; NTIS; INIS.

Some comments are given for making group averaged covariance matrices through an experience of preparation of a dosimetry cross section and covariance library for the spectrum adjustment code, 'NEUPAC'. (author).

6786 (KFK–5394) **First measurement of the energy spectrum of electron neutrinos from μ^+-decay.** Kleifges, M. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Kernphysik; Karlsruhe Univ. (T.H.) (Germany). Fakultaet fuer Physik. Aug 1994. 102p. (In German). Order Number DE95731723. Source: OSTI; NTIS (US Sales Only); INIS.

The neutrino experiment KARMEN has been performing measurements for more than 4 years at the spallation source ISIS at the Rutherford-Appleton-Laboratory in Great Britain. In the experiment the neutrinos ν_μ, ν_e and anti ν_μ from the pion decay chain in the ISIS target are detected in a 56t-liquid scintillator calorimeter. Besides the search for neutrino oscillation in the chanel $\nu_\mu \rightarrow \nu_e$ and anti $\nu_\mu \rightarrow$ anti ν_e the other main physics aim is the investigation of the neutrino-nucleus interaction by neutral and charged weak currents. This report concentrates on the exclusive nuclear excitation by the charged current $\nu_e + {}^{12}C \rightarrow {}^{12}N_{g.s.} + e^-$. Due to the sequential signature as a result of ^{12}N-decay this reaction allows an investigation with high signal to background ratio 34:1. The analysis of the data since June 1990 yields 291 events of which 8.3 were assigned to background events. Hence the flux averaged cross section of the exclusive nuclear excitation in the energy range 0-53 MeV was measured to be left angle σ right angle $_{cc}$=[9.1±0.55(stat.)±0.74(syst.)]x10^{-42} cm^2 which is in good agreement with theoretical calculations. Besides this result, the good calorimetric properties of the KARMEN detector make it possible to unfold the primary energy of the detected electrons. This unfolding enabled both the energy dependent cross section and the energy distribution of the electron neutrinos from unpolarized μ^+-decay to be determined. The measurement of the ν_e-energy spectrum from the μ^+-decay offers a totally new and highly sensitive possibility for the study of the Lorentz structure of this weak decay. The influence of possible scalar and tensor coupling components, that could give a hint on physics beyond the standard model, is described by the ν_e-Michel parameter ω_L.

6787 (LA-SUB–94-170) **Evaluation and compilation of fission product yields 1993.** England, T.R.; Rider, B.F. Los Alamos National Lab., NM (United States). [1995]. 173p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. Order Number DE95003450. Source: OSTI; NTIS; INIS; GPO Dep.

This document is the latest in a series of compilations of fission yield data. Fission yield measurements reported in the open literature and calculated charge distributions have been used to produce a recommended set of yields for the fission products. The original data with reference sources, and the recommended yields axe presented in tabular form. These include many nuclides which fission by neutrons at several energies. These energies include thermal energies (T), fission spectrum energies (F), 14 meV High Energy (H or HE), and spontaneous fission (S), in six sets of ten each. Set A includes U235T, U235F, U235HE, U238F, U238HE, Pu239T, Pu239F, Pu241T, U233T, Th232F. Set B includes U233F, U233HE, U236F, Pu239H, Pu240F, Pu241F, Pu242F, Th232H, Np237F, Cf252S. Set C includes U234F, U237F, Pu240H, U234HE, U236HE, Pu238F, Am241F, Am243F, Np238F, Cm242F. Set D includes Th227T, Th229T, Pa231F, Am241T, Am241H, Am242MT, Cm245T, Cf249T, Cf251T, Es254T. Set E includes Cf250S, Cm244S, Cm248S, Es253S, Fm254S, Fm255T, Fm256S, Np237H, U232T, U238S. Set F includes Cm243T, Cm246S, Cm243F, Cm244F, Cm246F, Cm248F, Pu242H, Np237T, Pu240T, and Pu242T to complete fission product yield evaluations for 60 fissioning systems in all. This report also serves as the primary documentation for the second evaluation of yields in ENDF/B-VI released in 1993.

6788 (LA-UR–94-3727) **The nuclear spin-isospin response to quasifree nucleon scattering.** Taddeucci, T.N. Los Alamos National Lab., NM (United States). [1995]. 17p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9409103–7: International symposia on high energy spin physics and polarization phenomena in nuclear physics, Bloomington, IN (United States), 15-22 Sep 1994). Order Number DE95003722. Source: OSTI; NTIS; INIS; GPO Dep.

The Neutron-Time-of-Flight (NTOF) facility at LAMPF has been used to measure complete sets of polarization-transfer coefficients for quasifree $(\vec{p},\vec{n})$ scattering from ^{2}H, ^{12}C, and ^{40}Ca at 494 MeV and scattering angles of 12.5°, 18°, and 27° (q = 1.2, 1.7, 2.5 fm^{-1}). These measurements yield separated transverse ($\sigma \times q$) and longitudinal ($\sigma \cdot q$) isovector spin responses. Comparison of the separated responses to calculations and to electron-scattering responses reveals a strong enhancement in the spin transverse channel. This excess transverse strength masks the effect of pionic correlations in the response ratio.

6789 (LA-UR–94-3744) **Second generation interferometry measurements at CERN.** Sullivan, J.P. Los Alamos National Lab., NM (United States). [1995]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9406291–1: 5. conference on the intersections of particle and nuclear physics, Tampa, FL (United States), 1-6 Jun 1994). Order Number DE95003724. Source: OSTI; NTIS; INIS; GPO Dep.

Source size parameters measured via two-particle interferometry in experiment NA44 for 200 GeV/nucleon S+Pb collisions are compared to calculations using the RQMD event generator. Reasonable agreement is found in most cases. The event generator is then used to compare the "true" size of the particle-emitting source to the measured size parameters and to discuss the difficulties in defining the "true" source size.

6790 (LA-UR–94-3967) **Pion and kaon freezeout in NA44.** NA44 Collaboration. Los Alamos National Lab., NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9406274–3: NATO Advanced Research workshop on hot hadronic matter: theory and experiment, Divonne-les-Bains (France), 27 Jun - 1 jul 1994). Order Number DE95003667. Source: OSTI; NTIS; INIS; GPO Dep.

The NA44 spectrometer is optimized for the study of single and two-particle particle spectra near mid-rapidity for transverse momenta below $\approx$ 1 GeV/c. A large fraction of all pairs in the spectrometer's acceptance are at low relative momenta, resulting in small statistical uncertainties on the extracted size parameters. In addition, the spectrometer's clean particle identification allows the authors to measure correlation functions for pions, kaons, and protons. This contribution will concentrate on the source size parameters determined from pion and kaon correlation functions. These size parameters will be compared to calculations from the RQMD event generator and also interpreted in the context of a hydrodynamic model. Finally, the measured single particle spectra will be examined from the viewpoint of hydrodynamics.

6791 (LBL–34831, pp. 49-60) **Space-time evolution of production of semihard QCD-quanta in ultrarelativistic heavy ion collisions.** Eskola, K.J. (Univ. of Helsinki (Finland)); Wang, Xin-Nian. Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors discuss the space-time evolution of initial parton production in ultrarelativistic heavy ion collisions within the framework of perturbative QCD. They use the uncertainty principle to address an average lifetime for a produced parton in terms of its energy and virtuality and consider the average duration of multiple independent semihard scatterings with initial and final state radiation. For central Au + Au collisions at $\sqrt{s}$ = 200 GeV, most of the partons are found to be produced within 0.5 fm/c after the total overlap of the two colliding nuclei. They also study the evolution of rapidity and momentum distributions, discuss the chemical composition of the formed semihard quark-gluon system and estimate when the system could reach momentum isotropy.

6792 (LBL–34831, pp. 61-72) **QCD based space-time description of high energy nuclear collisions.** Geiger, K. (Univ. of Minnesota, Minneapolis, MN (United States)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The current understanding of the early stage of heavy ion collisions at collider energies on the basis of the improved parton model and kinetic theory is presented. The space-time evolution of these reactions is investigated in terms of the dissipative dynamics of (semi)hard quark and gluon interactions within perturbative QCD. The partons' phase-space distributions are evolved in real time according to a transport equation through multiple collisions, emission and absorption processes. The resulting parton cascade picture is applied to study the issues of thermalization, chemical equilibration, and particle production in AA collisions at RHIC and LHC.

6793 (LBL–34831, pp. 313-320) **Exotic charmed baryon production in ultrarelativistic heavy ion collisions.** Zimanyi, J. (Central Research Institute for Physics, Budapest (Hungary)); Biro, T.S.; Levai, P. Lawrence Berkeley Lab., CA (United States). [1993]. Grant 2973. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

The authors investigate multi-heavy baryon formation in Au + Au collision using an extended version of the combinatoric break up model for rehadronization. A penalty factor, p, is introduced to characterize the coalescence probability of a light quark with a heavy one. At LHC energy large production rate is found for certain multi-heavy baryons and mesons such as Ω_{ccc}, Ξ_{cc}, J/Ψ and suppression for Λ_c, D. They speculate also on the possible existence of a heavy bottom-charm six-quark baryon. A semiclassical and a gaussian estimate reveal that the octet-octet bbb-cc configuration can be energetically favored with respect to the singlet-singlet one.

6794 (LBL–34831, pp. 329-340) **Relativistic heavy ion physics at CERN.** Gutbrod, H.H. (Gesellschaft fuer Schwerionenforschung, Geneva (Switzerland)). Lawrence Berkeley Lab., CA (United States). [1993]. (CONF-9308181–: Pre-equilibrium Parton dynamics, Berkeley, CA (United States), 23 Aug - 3 sep 1993). In *Pre-equilibrium parton dynamics: Proceedings.* 361p. Source: OSTI; NTIS; INIS.

A summary of the present data on light ion collisions at the CERN SPS is followed by a presentation of the new generation of experiments which will utilize the 160 AGeV lead beam due in November 1994. An outlook is given into the heavy ion program at the Large Hadron Collider LHC at CERN. The plans for the dedicated Heavy Ion Detector ALICE are described.

6795 (LBL–36250) **The physics and experimental program of the Relativistic Heavy Ion Collider (RHIC).** Harris, J.W. Lawrence Berkeley Lab., CA (United States). Sep 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9406274–2: NATO Advanced Research workshop on hot hadronic matter: theory and experiment, Divonne-les-Bains (France), 27 Jun - 1 jul 1994). Order Number DE95003416. Source: OSTI; NTIS; INIS; GPO Dep.

The primary motivation for studying nucleus-nucleus collisions at relativistic and ultrarelativistic energies is to investigate matter at high energy densities ($\varepsilon \gg 1$ GeV/fm^3). Early speculations of possible exotic states of matter focused on the astrophysical implications of abnormal states of dense nuclear matter. Field theoretical calculations predicted abnormal nuclear states and excitation of the vacuum. This generated an initial interest among particle and nuclear physicists to transform the state of the vacuum by using relativistic nucleus-nucleus collisions. Extremely high temperatures, above the Hagedorn limiting temperature, were expected and a phase transition to a system of deconfined quarks and gluons, the Quark-Gluon Plasma (QGP), was predicted. Such a phase of matter would have implications for both early cosmology and stellar evolution. The understanding of the behavior of high temperature nuclear matter is still in its early stages. However, the dynamics of the initial stages of these collisions, which involve hard parton-parton interactions, can be calculated using perturbative QCD. Various theoretical approaches have resulted in predictions that a high temperature (T $\sim$ 500 MeV) gluon gas will be formed in the first instants (within 0.3 fm/c) of the collision. Furthermore, QCD lattice calculations exhibit a phase transition between a QGP and hadronic matter at a temperature near 250 MeV. Such phases of matter may have existed shortly after the Big Bang and may exist in the cores of dense stars. An important question is whether such states of matter can be created and studied in the laboratory. The Relativistic Heavy Ion Collider (RHIC) and a full

complement of detector systems are being constructed at Brookhaven National Laboratory to investigate these new and fundamental properties of matter.

6796 (LBL–36299) **Spin polarization of ^{23}Mg in ^{24}Mg + Au, Cu and Al collisions at 91 A MeV.** Matsuta, K. (Osaka Univ., Osaka (Japan)); Fukuda, S.; Izumikawa, T. Lawrence Berkeley Lab., CA (United States). Sep 1994. 6p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract AC03-76SF00098. NASA Grant NGT-50783. (CONF-9409103–6: International symposia on high energy spin physics and polarization phenomena in nuclear physics, Bloomington, IN (United States), 15-22 Sep 1994). Order Number DE95003419. Source: OSTI; NTIS; INIS; GPO Dep.

Spin polarization of beta-emitting fragment ^{23}Mg(I^{π} = 3/2$^+$, $T_{1/2}$ = 11.3 s) produced through the projectile fragmentation process in ^{24}Mg + Au, Cu and Al collisions has been observed at 91 A MeV. General trend in the observed momentum dependence of polarization is reproduced well qualitatively by a simple fragmentation model based on the participant-spectator picture, for heavy and light targets. However the polarization behavior differs from this model in terms of zero crossing momentum, which become prominent in the case of Cu target, where the polarization is not monotone function of the fragment momentum.

6797 (LUNFD6-NFFR–1011/1-169(1994)) **High resolution (γ, n) experiments in light nuclei at $E_\gamma \simeq$ 60 MeV.** Andersson, Bengt Erik. Lund Univ. (Sweden). Dept. of Nuclear Physics. 30 Sep 1994. 186p. Order Number DE95610405. Source: OSTI; NTIS; INIS.

The experiments was undertaken to establish the real photon reaction mechanism on light nuclei in the intermediate photon-energy region. The shortage of high quality (γ, n) data was the main motivation for starting a systematic investigation of this reaction channel. In this work, ^{12}C and ^{16}O were examined. Two neutron detector arrays were built and tested. A state-of-the-art neutron spectrometer was constructed by combining these arrays with a high resolution ($\simeq$ 300 keV) photon tagger. The intrinsic time resolution of this spectrometer ($\simeq$ 800 ps) allowed an excellent neutron energy resolution to be achieved ($\simeq$ 1 MeV) with fairly short flight paths ($\simeq$ 6 m), thereby optimizing the geometrical efficiency ($\simeq$ 10 msr) of the apparatus. The excellent energy resolution of the spectrometer allowed individual states (or cluster of states) to be resolved. This resolution approaches that available for the (γ, p) reaction. For ^{12}C and ^{16}O the same states seen in the (γ, p) reaction were observed over an angular range from 30-115 degrees. The most important result, concerning the obtained absolute differential cross sections, is the striking similarity between the (γ, p) and (γ, n) reaction channels. This applies to both target nuclei for all populated states, independent of character (1h or 2h1p). A much detailed comparison is thus possible with these new data, providing greater constraints on the theoretical models. Further, access to more and better data will hopefully attract greater theoretical interest. The experiment was a collaboration between the Photonuclear research group at Lund University in Sweden and the Nuclear structure group from the University of Glasgow. The data were collected at MAX-lab in Lund, Sweden. 96 refs, 105 figs, 28 tabs.

6635 Nuclear Mass Ranges

Refer also to citation(s) 6432, 6761, 6762, 6766, 6768, 6772, 6773, 6774, 6775, 6777, 6779, 6783, 6786, 6787, 6788, 6789, 6790, 6791, 6796

6636 Radiation Physics

Refer also to citation(s) 6759, 6811

6798 (INIS-RU–379, pp. 34-36) **Evaluation of the Bragg law fluctuation at the calculation of proton slowing-down in SiO_2.** Aleksandrov, V.A.; Filippov, G.M. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

In simple examples with SiO_2 crystal the Bragg law is shown to increase the value of energy losses by particles moving in matter. The Bragg law fluctuations, reaching at low energies 20-30% with further proton energy increase, decrease gradually and they make up less than 2-3% for E_p > 600 keV. The importance of taking into account polarization of frames in dielectrics is pointed out. 2 refs., 2 figs.

6799 (INIS-RU–379, pp. 37-39) **Fluctuations of polarization fields.** Filippov, G.M. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Based on microscopic quantum field theory, polarization field fluctuations are calculated for a fast nonrelativistic charged particle moving from vacuum into the bulk solid and for a relativistic particle with the allowance for transverse modes. The derived formula is applicable to vacuum where it turns the values of polarization field fluctuations to zero. 4 refs.

6800 (INIS-RU–379, pp. 43-45) **Stopping power of solid absorbers for nitrogen and carbon ions in the range of maximum stopping power curve.** Mayatskij, V.D.; Chesnokova, T.D. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Data on stopping power (SP) measurements for solid absorbers carried out on N and C beams (E=0.4 MeV) in the geometry of transmission are summarized. SP data for C, Al, Ti, V, Fe, Ni, Cu, In, Sn, Ta, Au are obtained. The effective charge concept is shown to be a rough approximation in the field of a SP maximum curve. The data on SP values range to 20%. 6 refs., 1 fig.

6801 (INIS-RU–379, pp. 52-54) **Comparison of characteristics of coherent radiations from crystals and periodic radiators.** Andreyashkin, M.Yu.; Basaj, A.Yu.; Vorob'ev, S.A.; Zabaev, V.N.; Kaplin, V.V.; Uglov, S.R. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

First experimental results of investigation into transition X-radiation (TXR) on 90 MeV electron beam are presented. Angular distributions of resonance TXR in the range of tens of keV photons are in proportion $1:10^{-3}:10^{-6}$. That indicates the possibility of production of a highly intensive X-radiation source on the basis of resonance TXR. 9 refs.

6802 (INIS-RU–379, pp. 61-63) **Study of coherent pair production of B type in silicon crystal.** Andreyashkin, M.Yu.; Vorob'ev, S.A.; Basaj, A.Yu.; Zabaev, V.N.; Kunashenko, Yu.P.; Kalinin, B.N.; Pivovarov, Yu.L. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.*

Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The results of theoretical and experimental studies of energy dependence of cross sections for coherent e^+e^- pair production (at equal e^+ and e^- energies) in <100> Si crystal are presented. There is a maximum in the energy spectra at E_{ph}=260 MeV. The width and form of the maximum can be explained by the channeling effect on coherent type-B pair production. 7 refs., 2 figs.

6803 (INIS-RU–379, pp. 64-66) **Calculation of radiation and pair production probabilities at arbitrary incidence angles to crystal planes.** Tikhonirov, V.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The results of calculations of the intensity and polarization of radiation from channeled and unchanneled $e^{+-}$are presented. The Fourier transformation (FT) is used to calculate numerous matrix elements. The calculations for channeled e^+ showed fast approach of spectral intensity to its value calculated in the approximation of self-consistent field (ASCF) with growing photon energy. In the case of 150 GeV unchanneled e^- in <110> Ge at T=293 K the ASCF gives a significantly higher value as compared to the FT. 4 refs., 3 figs.

6804 (INIS-RU–379, pp. 79-81) **Comparison of diffraction intensity of bremsstrahlung photons and parametric X-radiation.** Verzilov, V.A.; Kalinin, B.N.; Potylitsyn, A.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

To compare the contributions from parametric X-radiation and diffraction bremsstrahlung, measurements are carried out of orientation dependences (OD) of photon emission for 900, 600 and 300 MeV electrons in silicon monocrystal. Whereas for 900 and 600 MeV case the calculations describe the experiment well, for 300 MeV electrons there is evidence for inconsistent form of OD which indicates the contribution of real photon diffraction. 5 refs.; 1 fig.; 1 tab.

6805 (JAERI-M–94-019, pp. 20-24) **Study of nuclear data in Indonesia.** Lasijo, R.S. (National Atomic Energy Agency, Jakarta (Indonesia)); Aziz, F.; Santoso, B.; Subki, I.R. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

A team for the installation of the evaluated nuclear data libraries has been formed. The team is expected to be the embryo for the formation of the nuclear data group in Indonesia. The first task of the team was to install the evaluated nuclear data libraries ENDF through the IAEA technical assistance. Experts from the IAEA have been sent to Indonesia to help the installation of the libraries together with the preprocessing and the processing codes, and to train the local scientists on the applications of several codes. Utilization of evaluated nuclear data in nuclear reactor core calculations is the most concerned objective in the moment. Applications in other fields like radiation protection and shielding, nuclear medicine, etc., may follow. The possibilities of working on the nuclear data measurements and evaluations are also considered. (author).

6806 (JAERI-M–94-019, pp. 159-161) **Environment of nuclear energy development and international cooperation of nuclear data activity.** Fuketa, Toyojiro (Nuclear Energy Data Center, Tokai, Ibaraki (Japan)). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

The world nuclear data activity achieved a reasonable level in the 1980's, and the power reactor development should have been given a stimulus. But, unfortunately the Chernobyl accident happened on 26th April 1986, since then the world nuclear energy development has been suffering from a very serious adverse wind, and governmental supports to the nuclear data activities in most countries have been declining also. It is clear for us that nuclear fission is the best major energy source for the preservation of the global environment in the foreseeable long future. More accurate nuclear data and hitherto unavailable kind of nuclear data are requisite for an advanced nuclear research and development. Under the existing circumstances of the nuclear data activity, an increased effort for the international cooperation in the nuclear data field is indeed required. (author).

6807 (JAERI-M–94-019, pp. 276-289) **Reevaluation of FP nuclear data for JENDL-3.2.** Kawai, M. (Toshiba Corp., Kawasaki, Kanagawa (Japan)). Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

Reevaluation of the nuclear data for about 60 fission product nuclides has been made for JENDL-3.2, taking accounts of the new experimental data and the results of integral tests for JENDL-3. As for thermal cross sections of long lived nuclides, JRR-4 measurements at JAERI were adopted. Major part of the revision of the resonance parameters were made according to the renormalization of the experimental capture-area data of ORNL. Capture cross sections were renormalized so as to reduce the contradiction between the differential and the integral data. For some nuclides, the optical model parameters were revised to improve the energy dependence of total and capture cross sections. Direct components were added to the inelastic scattering cross sections of Zr and Mo isotopes. As for deformed nuclides such as Sm and Nd isotopes, the coupled channel calculation was made for estimation of excitation functions of rotational levels. (author).

6640 Atomic and Molecular Physics

Refer also to citation(s) 6378

6808 (ANL/APS/TM–14) **Atomic physics at high brilliance synchrotron sources: Proceedings.** Berry, G.; Cowan, P.; Gemmell, D. Argonne National Lab., IL (United States). Aug 1994. 330p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-9404198–: Workshop on atomic physics at high brilliance synchrotron sources, Argonne, IL (United States), 23-24 Apr 1994). Order Number DE95006077. Source: OSTI; NTIS; INIS; GPO Dep.

This report contains papers on the following topics: present status of SPring-8 and the atomic physics undulator beamline; recent photoabsorption measurements in the rare gases and alkalis in the 3 to 15 keV proton energy region; atomic and molecular physics at LURE; experiments on atoms, ions and small molecules using the new generation of synchrotron radiation sources; soft x-ray fluorescence spectroscopy using tunable synchrotron radiation; soft x-ray fluorescence spectroscopy excited by synchrotron radiation: Inelastic and resonant scattering near threshold; outer-shell photoionization of ions; overview of the APS BESSRC beamline development; the advanced light source: Research opportunities in atomic and molecular physics; Photoionization of the Ba^+ ion by 4d shell excitation; decay dynamics of inner-shell excited atoms and molecules; absorption of atomic Ca, Cr, Mn and Cu; High-resolution photoelectron studies of resonant molecular photoionization; radiative and radiationless resonant raman scattering by synchrotron radiation; auger spectrometry of atoms and molecules; some thoughts of future experiments with the new generation of storage rings; Electron spectroscopy studies of argon

K-shell excitation and vacancy cascades; ionization of atoms by high energy photons; ion coincidence spectroscopy on rare gas atoms and small molecules after photoexcitation at energies of several keV; an EBIS for use with synchrotron radiation photoionization of multiply charged ions and PHOBIS; gamma-2e coincidence measurements the wave of the future in inner-shell electron spectroscopy; recoil momentum spectroscopy in ion-atom and photon-atom collisions; a study of compton ionization of helium; future perspectives of photoionization studies at high photon energies; and status report on the advanced photon source. These papers have been cataloged separately elsewhere.

6809 (DOE/ER/13394–T3) **Studies of autoionizing states relevant to dielectronic recombination. Progress report, July 1, 1991–June 30, 1994.** Gallagher, T.F. Virginia Univ., Charlottesville, VA (United States). Dept. of Physics. Dec 1993. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-85ER13394. Order Number DE94014162. Source: OSTI; NTIS; INIS; GPO Dep.

The goal of this research program supported by grant DE-FG05-85-ER13394 is to study the properties of autoionizing states to understand in detail dielectronic recombination of ions and electrons. During the period of the present grant, July 1, 1991–June 30, 1994, we have put substantial effort into the study of autoionizing states in Mg. The first topic we have investigated is the angular distribution of electrons ejected from the autoionizing Mg 3pns and 3pnd states. Both of these sets of measurements provide more stringent tests of the K matrix calculations than do measurements of total cross sections. The second topic is the effect of static and microwave electric fields on autoionizing states. Our previous measurements in Ba have shown the profound influence of electric fields on autoionization rates and we have made extensive new measurements in both Ba and Mg. Electric fields are of real importance for dielectronic recombination, since they are present as macroscopic fields in beam experiments and as microfields in plasmas. Finally, we have begun time resolved measurements. We have set up a picosecond laser system, and we have just finished the first experiment with it. Specifically we have used picosecond excitation from a bound Mg 3pnd Rydberg wave packet to the autoionizing 3pnd states to show explicitly the correlation between the spatial location of the Rydberg electron and the frequency of the exciting light.

6641 Theory of Electronic Structure of Atoms and Molecules

6810 (ANL/MCS/CP–84764) **Massively parallel self-consistent-field calculations.** Tilson, J.L. Argonne National Lab., IL (United States). Mathematics and Computer Science Div. 29 Oct 1994. 14p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-941128–3: Annual meeting of the American Institute of Chemical Engineers, San Francisco, CA (United States), 13-18 Nov 1994). Order Number DE95004128. Source: OSTI; NTIS; INIS; GPO Dep.

The advent of supercomputers with many computational nodes each with its own independent memory makes possible extremely fast computations. The author's work, as part of the US High Performance Computing and Communications Program (HPCCP), is focused on the development of electronic structure techniques for the solution of Grand Challenge-size molecules containing hundreds of atoms. Their efforts have resulted in a fully scalable Direct-SCF program that is portable and efficient. This code, named NWCHEM, is built around a distributed-data model. This distributed data is managed by a software package called Global Arrays developed within the HPCCP. They present performance results for Direct-SCF calculations of interest to the consortium.

6642 Spectra of Atoms and Molecules and Their Interactions With Photons

6811 (CIEMAT–732) **Calculation of photon attenuation coeficients of elements and compounds from approximate semi-analytical formulae.** Roteta, M.; Baro, J.; Fernandez-Varea, J.M.; Salvat, F. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 51p. Order Number DE95721643. Source: OSTI; NTIS; INIS.

The FORTRAN 77 code PHOTAC to compute photon attenuation coefficients of elements and compounds is described. The code is based on the semi-analytical approximate atomic cross sections proposed by Baro et al. (1994). Photoelectric cross sections are calculated directly from a simple analytical expression. Atomic cross sections for coherent and incoherent scattering and for pair production are obtained as integrals of the corresponding differential cross sections. These integrals are evaluated, to a pre-selected accuracy, by using a 20-point Gauss adaptive integration algorithm. Calculated attenuation coefficients agree with recently compiled databases to within equal 1%, in the energy range from 1 KeV to 1 GeV. The complete source listing of the program PHOTAC is included.

6812 (PNL–10203) **Krypton isotope analysis using near-resonant stimulated Raman spectroscopy.** Whitehead, C.A.; Cannon, B.D.; Wacker, J.F. Pacific Northwest Lab., Richland, WA (United States). Dec 1994. 22p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-76RL01830. Order Number DE95005061. Source: OSTI; NTIS; INIS; GPO Dep.

A method for measuring low relative abundances of ^{85}Kr in one liter or less samples of air has been under development here at Pacific Northwest Laboratory. The goal of the Krypton Isotope Laser Analysis (KILA) method is to measure ratios of 10^{-10} or less of ^{85}Kr to more abundant stable krypton. Mass spectrometry and beta counting are the main competing technologies used in rare-gas trace analysis and are limited in application by such factors as sample size, counting times, and selectivity. The use of high-resolution lasers to probe hyperfine levels to determine isotopic abundance has received much attention recently. In this study, we report our progress on identifying and implementing techniques for trace ^{85}Kr analysis on small gas samples in a static cell as well as limitations on sensitivity and selectivity for the technique. High-resolution pulsed and cw lasers are employed in a laser-induced fluorescence technique that preserves the original sample. This technique, is based on resonant isotopic depletion spectroscopy (RIDS) in which one isotope is optically depleted while preserving the population of a less abundant isotope. The KILA method consists of three steps. In the first step, the $1s_5$ metastable level of krypton is populated via radiative cascade following two-photon excitation of the $2p_6$ energy level. Next, using RBDS, the stable krypton isotopes are optically depleted to the ground state through the $1s_4$ level with the bulk of the ^{85}Kr population being preserved. Finally, the remaining metastable population is probed to determine ^{85}Kr concentration. The experimental requirements for each of these steps are outlined below.

6643 Collision Phenomena

6813 (GSI–94-57(prepr.)) **Doppler-shift assisted fast ion spectroscopy: a case study for X-ray emission from 277 MeV/u Pb^{81+} ions.** Mokler, P.H.; Stoehlker, T.; Kozhuharov, C.; Moshammer, R.; Rymuza, P.; Stachura, Z.; Warczak, A. Gesellschaft fuer Schwerionenforschung mbH, Darmstadt (Germany). Sep 1994. 27p. Order Number DE95725942. Source: OSTI; NTIS (US Sales Only); INIS.

Utilizing the different information from spatially separated segments of high-granular photon detectors the measured (LAB) energy of photons emitted by fast moving ions can be corrected individually for the Doppler effect according to the particular observation angles of each detector segment. By a redundant fitting procedure the center of mass photon energy can be determined with high precision. This new Doppler-shift assisted spectroscopy is explained for the case study of 277.4 MeV/u Pb^{82+} ions colliding with a N_2-gas target at the heavy ion storage ring ESR. Spectroscopic information for hydrogenic Pb^{81+} ions is given for the ground-state transitions, for the Balmer transitions, as well as for the total K-binding energy. (orig.)

6814 (LBL–36080) **A discrete variable representation for electron-hydrogen atom scattering.** Gaucher, L.F. Lawrence Berkeley Lab., CA (United States). Aug 1994. 152p. Sponsored by

USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95003436. Source: OSTI; NTIS; INIS; GPO Dep.

A discrete variable representation (DVR) suitable for treating the quantum scattering of a low energy electron from a hydrogen atom is presented. The benefits of DVR techniques (e.g. the removal of the requirement of calculating multidimensional potential energy matrix elements and the availability of iterative sparse matrix diagonalization/inversion algorithms) have for many years been applied successfully to studies of quantum molecular scattering. Unfortunately, the presence of a Coulomb singularity at the electrically unshielded center of a hydrogen atom requires high radial grid point densities in this region of the scattering coordinate, while the presence of finite kinetic energy in the asymptotic scattering electron also requires a sufficiently large radial grid point density at moderate distances from the nucleus. The constraints imposed by these two length scales have made application of current DVR methods to this scattering event difficult.

6815 (UCRL-JC–117932) **Toward improved photon-atom scattering predictions.** Kissel, L. Lawrence Livermore National Lab., CA (United States). 21 Oct 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-941129–10: 13. international conference on the application of accelerators in research and industry, Denton, TX (United States), 7-10 Nov 1994). Order Number DE95003651. Source: OSTI; NTIS; INIS; GPO Dep.

Photon-atom scattering is important in a variety of applications, but scattering from a composite system depends on the accurate characterization of the scattering from an isolated atom or ion. We have been examining the validity of simpler approximations of elastic scattering in the light of second-order S-matrix theory. Partitioning the many-body amplitude into Rayleigh and Delbrueck components, processes beyond photoionization contribute. Subtracted cross sections for bound-bound atomic transitions, bound pair annihilation, and bound pair production are required in anomalous scattering factors for: (1) convergence of the dispersion integral; (2) agreement with predictions of the more sophisticated S-matrix approach; (3) satisfying the Thomas-Reiche-Kuhn sum rule. New accurate tabulations of anomalous scattering factors have been prepared for all Z, for energies 0–10,000 keV, within the independent particle approximation (IPA) using a Dirac-Slater model of the atom. Separately, experimental atomic photoabsorption threshold information has been used to modify these IPA predictions for improved comparison with experiment.

6644 Experimentally Derived Information On Atomic and Molecular Properties

Refer also to citation(s) 6387

6816 (LBL–36079) **Study of radicals, clusters and transition state species by anion photoelectron spectroscopy.** Arnold, D.W. Lawrence Berkeley Lab., CA (United States). Aug 1994. 481p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Order Number DE95003438. Source: OSTI; NTIS; INIS; GPO Dep.

Free radicals, elemental and van der Waals clusters and transition state species for bimolecular chemical reactions are investigated using anion photoelectron spectroscopy. Several low-lying electronic states of ozone have been identified via photoelectron spectroscopy of O_3^-. A characterization of these states is important to models for atmospheric ozone reaction kinetics. The fluoroformyloxyl radical, FCO_2, has been investigated, providing vibrational frequencies and energies for two electronic states. The technique has also been employed to make the first direct observation and characterization of the NNO_2 molecule. Several electronic states are observed for this species which is believed to play a role as a reactive intermediate in the $N + NO_2$ reaction. The experimental results for all three of these radicals are supplemented by ab initio investigations of their molecular properties. The clusters investigations include studies of elemental carbon clusters ($C_2^- - C_{11}^-$), and van der Waals clusters ($X^-(CO_2)_n$, X = I, Br, Cl; $n \leq 13$ and $I^- (N_2O)_{n=1--11}$). Primarily linear clusters are observed for the smaller carbon clusters, while the spectra of the larger clusters contain contribution from cyclic anion photodetachment. Very interesting ion-solvent interactions are observed in the $X^-(CO_2)n$ clusters. The transition state regions for several bimolecular chemical reactions have also been investigated by photodetachment of a negative ion precursor possessing a geometry similar to that of the transition state species. These spectra show features which are assigned to motions of the unstable neutral complex existing between reactants and products.

6817 (UCRL-JC–117928) **Na-like autoionizing levels: Plasma diagnostics and prospects for photopumped soft x-ray lasers.** Osterheld, A.L. (and others); Dunn, J.; Young, B.K.F. Lawrence Livermore National Lab., CA (United States). Aug 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940592–10: 4. international colloquium on X-ray lasers, Williamsburg, VA (United States), 16-20 May 1994). Order Number DE95004207. Source: OSTI; NTIS; GPO Dep.

We have investigated the kinetics of doubly excited sodium-like copper states with $3131'$ and $3141'$ configurations, and the feasibility of photopumped x-ray lasing schemes and plasma diagnostics using transitions from these levels. These x-ray lasing schemes, like similar lasing schemes in Li-like ions, have high quantum efficiency and potentially reduced radiative trapping effects. In addition, the satellite transitions emitted by these sodium-like levels may provide valuable diagnostics of x-ray laser plasmas.

6645 Special Atoms and Molecules

6818 (INIS-RU–379, pp. 58-60) **Coherent photoproduction of a relativistic positronium atom.** Kunashenko, Yu.P.; Pivovarov, Yu.L. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Relativistic positronium atom photoproduction in crystals and amorphous targets is investigated. Coherent production turned out to be a most promissing process. The cross section of this process is by an order of magnitude higher than in amorphous target, and the yield $A_{2\gamma}$ can make up to 10^{-9}/photon: Ge <100> at $E \geq 250$ MeV. 7 refs., 2 figs.

6650 Physics of Condensed Matter

Refer also to citation(s) 6175

6819 (SAND–93-3866C) **Impact shock and penetration fragmentation in porous media.** Trucano, T.; Grady, D. Sandia National Labs., Albuquerque, NM (United States). [1994]. 27p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9410131–6: 1994 hypervelocity impact symposium, Santa Fe, NM (United States), 16-20 Oct 1994). Order Number DE94018900. Source: OSTI; NTIS; GPO Dep.

In this paper, we discuss experimental, analytical, and computational techniques for studying the high velocity interaction of solid bodies with low density media. We assume that the velocity of the interaction is such that compressible effects in the solid are important. We are particularly interested in the dynamic mechanisms of deformation, erosion, and breakup which dominate the solid response at these high velocities. This is a problem of considerable current interest. Applications include the atmospheric propagation of high velocity aerosols, such as those that might be created in certain kinds of nuclear reactor accidents and explosive weapon accidents. An even more novel application is to the study of the impact of astrophysical bodies, such as meteors, asteroids, and comet fragments into planetary atmospheres. There is significant concern over the threats posed by impacts of these kinds on the earth. We will discuss the application of our methodology to understanding these impacts. In particular, we suggest that the experimental technique we present is applicable to scaled laboratory

simulations of some of the phenomena that are believed to be important in atmospheric impacts.

6651 Nuclear Techniques In Condensed Matter Physics

Refer also to citation(s) 6250, 6831

6820 (INIS-RU–379, pp. 137-139) **The effect of low-energy oxygen ions on structural perfection of monocrystalline films of yttrium ferrite-garnets.** Kibardin, A.V.; Pyatkova, T.M.; Stognij, A.I.; Tokarev, V.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The structure and chemical composition of epitaxial films of YFG grown on Ga-Gd garnet substrates are investigated. It is shown that irradiation of YFG epitaxial films by heavy current oxygen ion beams at all energies under study results in increasing structural perfection at the depth exceeding the defect surface flow. Ar^+ low-energy ions contribute to a less extent in the improvement of structural perfection of the samples. 1 fig.

6821 (INIS-RU–379, pp. 142-143) **Determination of a deformation profile in alpha-irradiated lead chalcogenide films.** Freik, D.M.; Kravets, V.I.; Ogorodnik, Ya.V.; Ruvinskij, M.A.; Kupchak, V.N.; Didyk, B.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Computer calculation are carried out of the deformation profile in 5.5 MeV alpha-irradiated PbTe films at 20 deg C. It is determined that at the dose $\Phi \geq 1x4,3x10^{12}$ cm^{-2} structural disordering, growth of microstrains, dislocation density and microhardness take place in the films. For doses $3x4,3 \leq \Phi \leq 24x4,3x10^{12}$ cm^{-2} maximum deformation profiles and their effective values are obtained. 3 refs.; 2 figs.

6822 (INIS-RU–379, pp. 149-151) **Li impurity atom position in $Nd_2CuO_{4-\delta}$ crystal lattice.** Borovik, A.S.; Epifanov, A.A.; Makarov, V.I.; Malyshevskij, V.S.; Skakun, N.A.; Slabospitskij, R.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Using the $^7Li(p, \alpha^4)He$ reaction with 1 MeV incident proton beam, the angular dependence of the reaction yield are measured on Li impurity atoms in $Nd_2CuO_{4-\delta}$ crystal oriented in <001> and <111> directions. The measurement results for <001> direction showed that 35% of Li atoms are located in the mixed Nd-Cu chain (Li(1)), and 50% of them are placed at the distance $\simeq$0.73 A from the mixed (Li(2)) chain. For the <111> axis it is found that a major part of Li impurity atoms takes the central position in the channel. 4 refs.; 4 figs.

6823 (INIS-RU–379, pp. 152-154) **Accurate measurement of oxigen profule in oxide films using resonance in helium ion elastic scattering at the energy of 3,045 MeV.** Kobzev, A.P.; Korneev, D.A.; Chernenko, L.P.; Shirokov, D.M. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The results of accurate measurements of oxygen depth distribution in SiO_2 and superconduting $YBa_2Cu_3O_7$ grown on $TiSiO_2$ substrate are presented. The average value of oxygen content in SiO_2 is found to be 66.68%, in $SrTiO_3$ it is 59.23 ± 0.14%. The measurement accuracy is 0.1. 3 refs.; 3 figs.

6824 (INIS-RU–379, pp. 155-157) **Nuclear physics methods of the determination of oxygen content in materials.** Verbitskaya, E.M. (and others); Dyumin, A.N.; Eremin, V.K. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The possibility of determination of oxygen content both in the surface and in the bulk of HTcSC $YBa_2Cu_3O_x$ ceramics is realized using the $^{16}O(d, \alpha)^{14}N$ reactions. The energy of alpha particles indicates the depth of the damaged layer, and the quantity of alpha particles indicates oxygen concentration in the layer. 6 refs.; 1 fig.; 1 tab.

6825 (INIS-RU–379, pp. 158-160) **Crystal structure of multilayered HTSC films investigated by the method of mean energy ion scattering.** Afrosimov, V.V.; Dzyuba, G.O.; Il'in, R.N.; Karmanenko, S.F.; Panov, M.N.; Sakharov, V.I.; Serenkov, I.T.; Chakalov, R. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Using mean energy ion channeling the disorientation value $\delta \simeq 0.9$ in $YBa_2Cu_3O_{6+\delta}$ films and a share of polycrystalline phase are determined. The calculation for 230 keV protons gives the value $\chi \simeq 0.2$, where χ is a relative ion yield in the absence of disordering, which gives evidence for a polycrystalline phase in the film. 2 refs.; 4 figs.

6826 (INIS-RU–379, pp. 164-166) **Reconstruction of impurity concentration profile by the resonance nuclear reaction method.** Zabashta, O.I.; Kul'ment'ev, A.I.; Nesterenko, A.E.; Storizhko, V.E.; Dikij, N.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Impurity concentration profile (ICP) is determined in molybdenum doped with 10 keV argon ions by solving the integral equation. The reconstruction of the ICP is carried out from the $^{40}Ar(p, \alpha\gamma)$ reaction yield. Argon concentration maximum is found to the depth $\approx$10 mkg/cm^2. 2 refs.; 1 fig.

6827 (INIS-RU–379, pp. 167-169) **Estimation of the degree of authenticity of concentrational element profile derived from RBS measurements.** Egorov, V.K.; Okhulkov, A.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A simple technique is offered for estimating the degree of authenticity of element concentrational profile which does not depend on the complicated character of RBS spectra and possible intercorrelation of parameters. The technique can be implemented with any program simulating RBS spectra, for instance, RUMP. 5 refs.; 1 fig.; 1 tab.

6828 (LA-UR–94-3872) **Phonon characteristics of high T_c superconductors from neutron Doppler broadening measurements.** Trela, W.J. (Los Alamos National Lab., NM (United States)); Kwei, G.H.; Lynn, J.E.; Meggers, K. Los Alamos National Lab., NM (United States). [1994]. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941144–14: 1994 fall meeting of the Materials Research Society (MRS), Boston, MA (United States), 28 Nov - 2 dec 1994). Order Number DE95003703. Source: OSTI; NTIS; INIS; GPO Dep.

Statistical information on the phonon frequency spectrum of materials can be measured by neutron transmission techniques if they contain nuclei with low energy resonances, narrow enough to be Doppler-broadened, in their neutron cross sections. The authors have carried out some measurements using this technique for materials of the lanthanum barium cuprate class, $La_{2-x}Ba_xCuO_4$. Two samples with slightly different concentrations of oxygen, one being superconductive, the other not, were examined. Pure lanthanum cuprate was also measured. Lanthanum, barium and copper all have relatively low energy narrow resonances. Thus it should be possible to detect differences in the phonons carried by different kinds of atom in the lattice. Neutron cross section measurements have been made with high energy resolution and statistical precision on the 59m flight path of LANSCE, the pulsed spallation neutron source at Los Alamos National Laboratory. Measurements on all three materials were made over a range of temperatures from 15K to 300K, with small steps through the critical temperature region near 27K. No significant changes in the mean phonon energy of the lanthanum atoms were observed near the critical temperature of the super-conducting material. It appears however that the mean phonon energy of lanthanum in the superconductor is considerably higher than that in the non-superconductors. The samples used in this series of experiments were too thin in barium and copper to determine anything significant about their phonon spectra.

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Refer also to citation(s) 5491, 5492, 6254, 6915

6829 (INIS-mf–14419, pp. 77-81) **Some properties of irradiated Estrofol foil.** Fiderkiewicz, A. (Institute of Nuclear Chemistry and Technology, Warsaw (Poland)); Buczkowski, M.; Zhitariuk, N.I.; Orelovich, O.L.; Shtanko, N.I.; Kovalev, B.N. Institute of Nuclear Chemistry and Technology, Warsaw (Poland); Glowny Inst. Gornictwa, Katowice (Poland). 1992. 90p. (CONF-9112186–: 2. meeting on particle track membranes and their applications, Szczyrk (Poland), 2-6 Dec 1991). In *Particle track membranes and their applications. Proceedings of the 2. Meeting 2-6 December 1991, Szczyrk, Poland.* Order Number DE95609886. Source: OSTI; NTIS; INIS.

The experiments were performed to investigate some properties of foils irradiated by electrons with dose range 1-3 MGy. The initiation of graft polymerization, mechanical properties and structure of irradiated Estrofol film have been investigated. 11 refs, 4 figs.

6830 (INIS-RU–379) **Proceedings of 22. international meeting on the physics of interaction of charged particles with crystals.** Tulinov, A.F.; Khodyrev, V.A. (eds.). AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The reports presented here are devoted to the results of theoretical and experimental studies in physics of orientation effects on the interaction of charged particles with crystals, their applications in nuclear physics, solid-state physics, in solving technological and materials science problems.

6831 (INIS-RU–379, pp. 9-11) **Electron channeling and electron microscopy of atomic resolution.** Vergasov, V.L. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The problem of crystal lattice image formation is considered in terms of channeling theory. At that, electron backscattering being a quantum mechanics effect in electron microscopy is implemented when beam incidence and crystallographic axis directions coincide. Potential wells of atomic chains are not deep and they only insert a small number of the filled levels of bound motion. 3 refs.

6832 (INIS-RU–379, pp. 12-13) **Coherent excitation of Ne^{9+} ion in Au crystal. Computerized simulation.** Krivosheev, O.Eh.; Pivovarov, Yu.L. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Computer calculations are carried out of coherent excitation of Ne^{9+} ions passing through 0.2 μkm Au crystal. A real trajectory in the field of many atomic axis is simulated and a nonstationary Schroedinger equation is solved. The method enables the calculation of charge state of probable excitation and X radiation after ion beam passage through the crystal at energies close to resonance ones. 5 refs., 1 fig.

6833 (INIS-RU–379, pp. 14-16) **Coulomb excitation of nuclei in crystals by protons and antiprotons.** Pivovarov, Yu.L. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Coulomb excitation (CE) of ^{19}F nuclei in LiF crystals by protons and antiprotons is considered, in particular the difference in the cross sections of CE determined by crystal orientation. It is shown that at disorientation of proton/antiproton beams relative to a crystal axis, orientational dependence of CE cross sections occurs. The difference in CE cross section is only related with the allowance for Coulomb repulsion at low energies. 3 refs.

6834 (INIS-RU–379, pp. 17-19) **Anomalous peculiarities and positron-like channeling of relativistic electron in magnetic crystals.** Vysotskij, V.I.; Kuz'min, R.N.; Maksyuta, N.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A possibility of positron-like electron channeling during axial motion of relativistic electrons in one-domain ferro- and antiferromagnetic crystals is investigated. The problem is analyzed by using the Klein-Gordon equation. Analysis shows that the most attractive for channeling are antiferromagnetic structures, where there is almost a parabolic potential well. The depth of the potential magnetic wells and barriers in interaxial space for rare earth magnetics can attain 1 eV. 1 ref., 1 fig.

6835 (INIS-RU–379, pp. 20-22) **Acoustic analysis of the efficiency of beam deflection by a bended crystal.** Denisov, F.P.; Il'in, S.I.; Potylitsyn, A.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The acoustic method of determination of the efficiency of charged particle beam deflection by a bended crystal is discussed. The method relies on measurement of the amplitude of an acoustic signal excited by channeling particles. The sensitivity of the method for 10 TeV proton beams is estimated. It made up about 10^6 particles per pulse. 7 refs.

6836 (INIS-RU–379, pp. 23-25) **Antiproton channeling.** Grankina, T.V.; Pokhil, G.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A share of channeled antiprotons suffered abnormally small losses and whose penetration depth is longer than their range is analyzed. Bound 4 MeV protons moving along the <100> Si axis are investigated. The energy spectrum of antiprotons penetrated at the level of 200 μkm has only shown the emission of axially channeling particles having energy $\approx$2.5 MeV. Particles not channeling have the range $\approx$160 μkm and they stop moving in the crystal. 3 refs., 4 figs.

6837 (INIS-RU–379, pp. 26-28) **Interaction of oxygen ions with the crystal lattice of Si-detector at channeling.** Eremin, V.K. (AN SSSR, Leningrad (Russian Federation). Fiziko-Tekhnicheskij Inst.); Medvedev, L.S.; Strokan, N.B.; Kobzev, A.P.; Shirokov, D.M. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A possibility of investigation of elastic scattering, atom ionization is analyzed using Si-detector as a target at oxygen ion channeling. Amplitude spectra were detected for various incidence angles of 1.5 and 2.0 MeV oxygen ions. 60 keV amplitude shift for oxygen and 50% reduction in half widths for a channeling peak are determined. 5 refs., 1 fig.

6838 (INIS-RU–379, pp. 29-31) **Energy dependence of the intensity of backscattering of fast electrons by highly symmetric crystals.** Makarov, V.V.; Solov'ev, S.V.; Pavlov, D.A. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Nonmonotonous energy dependence of the intensity of 10 keV electron backscattering I(E) during irradiation of highly oriented silicon crystal is calculated. The calculations showed that in some cases on the curves I(E) there can be seen narrow $\approx$10 eV peaks the value of which grows with growing temperature. 3 refs., 2 figs.

6839 (INIS-RU–379, pp. 32-33) **A new technique for analyzing crystal structures by electron channeling image processing.** Makarov, V.V.; Solov'ev, S.V.; Pavlov, D.A. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A technique is developed for computer-aided processing of electron channeling images. The technique enables three-dimensional analysis of the structure of the reciprocal crystal lattice and it ensures measurement of the backscattering intensity which corresponds to its lattice points. The technique is suggested to be used in investigation of defect formation at ion implantation. 1 fig.

6840 (INIS-RU–379, pp. 40-42) **Changes in electrophysical properties of silicon at multistep ion implantation.** Volod'ko, V.G.; Tkach, B.Ya.; Lesnikov, V.P.; Mazur, O.I. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The paper is aimed at revealing long-range interaction using a special means of ion implantation which implements stepwise irradiation of a rotating substrate open to an ion beam from both sides (the front and back). The substrates were irradiated with 40 keV Ar, N, P ions. There was a strong evidence for an amorphous phase at the depth of 1400 A in the irradiated plates of monocrystalline silicon and a polycrystalline phase at the depth of 2000 A. 3 refs.

6841 (INIS-RU–379, pp. 46-48) **Calculation of ion depth distribution at axial channeling with the allowance for multiple scattering and energy loss fluctuations.** Samarin, V.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The method of multiple scattering and energy loss fluctuations at calculation of ion depth distribution in amorphous material is extended to the case of axial ion channeling. The calculations of phosphorous, aluminium and calcium ions with the energies from 50 to 400 keV at their axial channeling in silicon are in good agreement with the experimental data. 4 refs., 2 figs.

6842 (INIS-RU–379, pp. 67-69) **On the possibility of one-frequency quasicharacteristic radiation generation at coherent channeling in crystals.** Vysotskij, V.I.; Kuz'min, R.N.; Maksyuta, N.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A possibility of generation of quasi-characteristic radiation with only one discrete line in X-radiation spectrum is considered for the case of coherent relativistic particle (electrons) channeling with full self-suppression of other discrete and continous lines in the usual quasi-characteristic radiation spectrum. 2 refs.

6843 (INIS-RU–379, pp. 70-72) **A set of programs describing electromagnetic processes at relativistic particle motion in the periodic potential of crystal field.** Nichipor, I.V.; Feranchuk, I.D.; Ul'yanenkov, A.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged

particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A set of programs is suggested to calculate band and radiation spectra from the Schroedinger equation with an arbitrary periodical potential defining the channeling relativistic particles (E=1-500 MeV). The program takes into account the radiation spectrum formation by summing up supbarrier, subbarier and intermediate energy-level transitions. It enables an approximate calculation of dechanneling processes. 5 refs.

6844 (INIS-RU–379, pp. 73-76) **Distortions in B-type coherent bremsstrahlung spectra of channeling relativistic electrons.** Amosov, K.Yu.; Balayan, A.S.; Vnukov, I.E.; Kalinin, B.N.; Naumenko, G.A.; Potylitsyn, A.P.; Sarychev, V.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Relations and differences between the two mechanisms of gamma quanta generation by electrons (E=100-200 MeV) in <100> diamond monocrystals: coherent bremsstrahlung (CB) and radiation at channeling are revealed. The 'splitting' in the peak of the spectrum due to electron channeling is discovered. The CB process can be used for production of quasimonochromatic photon beams. 9 refs.; 4 figs.

6845 (INIS-RU–379, pp. 77-78) **Study of positron beam production at electron channeling in tungsten.** Amosov, K.Yu.; Balayan, A.S.; Vnukov, I.E.; Kalinin, B.N.; Naumenko, G.A.; Potylitsyn, A.P.; Sarychev, V.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Spectra of positrons generated of 900 MeV electron-induced radiation in tungsten and tantalum monocrystals are measured. Because of high intensity and narrow focus of radiation at electron channeling the positron emission in the energy range 4-20 MeV for an oriented crystal is 3-4 times higher than it is for a disoriented one. With growing positron energy the yield ratio decreases up to 1 at positron energy E=80-90 MeV and it becomes less than 1 at higher energies. 6 refs.; 1 fig.

6846 (INIS-RU–379, pp. 87-89) **Diffusion of boron implanted into silicon irradiated by high-energy argon ions.** Varichenko, V.S.; Didyk, A.Yu.; Zajtsev, A.M.; Kazyuchits, N.M.; Kudelevich, N.A.; Chelyadinskij, A.R. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The diffusion of 100 keV boron ions implanted into Si irradiated by high-energy (46,3 MeV) Ar ions is investigated. Ar^+ ion implantation is shown to result in a 12 mkm surface defective layer where there is a 'plato' at the depth of 5 mkm and then defect concentration growth with the depth was seen. The absence of defect influence on the impurity re-distribution indicates the possible use of high-energy ion doping together with ion implantation at ordinary energies of ion beams within one technological cycle. 3 refs.; 3 figs.

6847 (INIS-RU–379, pp. 90-92) **Accumulation of radiation defects in silicon at high-energy ion implantation.** Varichenko, V.S.; Didyk, A.Yu.; Zajtsev, A.M.; Kazyuchits, N.M.; Mel'nikov, A.A.; Skuratov, V.A.; Chelyadinskij, A.R. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Radiation defect depth distribution in the destructed layer, defect formation and annealing in the surface layer of Si crystals implanted with 1 MeV Ne^+, Ar^+ and Kr^+ ions at room temperature are investigated. A similar picture of defect formation is shown: the defect concentration increase decrease in defect formation rate at a certain typical of each ion dose. 2 figs.

6848 (INIS-RU–379, pp. 93-95) **Defect formation in silicon irradiated by high-energy argon ions.** Azarko, I.I.; Varichenko, V.S.; Kazyuchits, N.M.; Penina, N.M.; Tolstykh, V.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The EPR method was used to study the peculiarities of paramagnetic defect formation in silicon irradiated by 47 MeV Ar^+ ions. Spectral analysis has shown the formation of point defects (PD) and isolated amorphous domains (AD). The formation of AD occured due to maximum accumulation of PD in the 12 mkm layer and due to the formation of AD immediately in the domain of defect accumulation. 3 refs.; 3 figs.

6849 (INIS-RU–379, pp. 96-98) **Influence of ion flux density and irradiation time on the long-range interaction effect.** Sorvina, V.P.; Tetel'baum, D.I. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The effects of irradiation time (argon 40 keV ions) and ion flux density (j) on silicon microhardness on the opposite to the irradiated side of silicon plate and, cosequently, on the behavior of defects in semiconductor's layer adjacent to the unirradiated surface were studied. Measurements were carried out under the load of 20 G. It is shown that the higher ion flux density, the more probable dislocation-type defect formation is. At small values of j microhardness on the unshielded part of the plate is lower than it is on the shielded one. At great values of j the inverse relation takes place. 3 refs.; 2 figs.

6850 (INIS-RU–379, pp. 116-117) **Structural changes in GaAs doped with selenium ions.** Kaparov, S.E.; Kudyshev, A.N. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The investigation results on structural changes in ion-doped layer of GaAs are presented. The samples were doped with 450 keV Se^+ ions. Radiation dose and temperature dependences of the formation of clusters and dislocation loops in GaAs during its annealing are reported. 6 refs.

6851 (INIS-RU–379, pp. 118-120) **The effect of size-energy factor on mass transfer at ion implantation of two-layer films.**

6835 (INIS-RU–379, pp. 20-22) **Acoustic analysis of the efficiency of beam deflection by a bended crystal.** Denisov, F.P.; Il'in, S.I.; Potylitsyn, A.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The acoustic method of determination of the efficiency of charged particle beam deflection by a bended crystal is discussed. The method relies on measurement of the amplitude of an acoustic signal excited by channeling particles. The sensitivity of the method for 10 TeV proton beams is estimated. It made up about 10^6 particles per pulse. 7 refs.

6836 (INIS-RU–379, pp. 23-25) **Antiproton channeling.** Grankina, T.V.; Pokhil, G.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A share of channeled antiprotons suffered abnormally small losses and whose penetration depth is longer than their range is analyzed. Bound 4 MeV protons moving along the <100> Si axis are investigated. The energy spectrum of antiprotons penetrated at the level of 200 μkm has only shown the emission of axially channeling particles having energy $\approx$2.5 MeV. Particles not channeling have the range $\approx$160 μkm and they stop moving in the crystal. 3 refs., 4 figs.

6837 (INIS-RU–379, pp. 26-28) **Interaction of oxygen ions with the crystal lattice of Si-detector at channeling.** Eremin, V.K. (AN SSSR, Leningrad (Russian Federation). Fiziko-Tekhnicheskij Inst.); Medvedev, L.S.; Strokan, N.B.; Kobzev, A.P.; Shirokov, D.M. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A possibility of investigation of elastic scattering, atom ionization is analyzed using Si-detector as a target at oxygen ion channeling. Amplitude spectra were detected for various incidence angles of 1.5 and 2.0 MeV oxygen ions. 60 keV amplitude shift for oxygen and 50% reduction in half widths for a channeling peak are determined. 5 refs., 1 fig.

6838 (INIS-RU–379, pp. 29-31) **Energy dependence of the intensity of backscattering of fast electrons by highly symmetric crystals.** Makarov, V.V.; Solov'ev, S.V.; Pavlov, D.A. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Nonmonotonous energy dependence of the intensity of 10 keV electron backscattering I(E) during irradiation of highly oriented silicon crystal is calculated. The calculations showed that in some cases on the curves I(E) there can be seen narrow $\approx$10 eV peaks the value of which grows with growing temperature. 3 refs., 2 figs.

6839 (INIS-RU–379, pp. 32-33) **A new technique for analyzing crystal structures by electron channeling image processing.** Makarov, V.V.; Solov'ev, S.V.; Pavlov, D.A. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A technique is developed for computer-aided processing of electron channeling images. The technique enables three-dimensional analysis of the structure of the reciprocal crystal lattice and it ensures measurement of the backscattering intensity which corresponds to its lattice points. The technique is suggested to be used in investigation of defect formation at ion implantation. 1 fig.

6840 (INIS-RU–379, pp. 40-42) **Changes in electrophysical properties of silicon at multistep ion implantation.** Volod'ko, V.G.; Tkach, B.Ya.; Lesnikov, V.P.; Mazur, O.I. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The paper is aimed at revealing long-range interaction using a special means of ion implantation which implements stepwise irradiation of a rotating substrate open to an ion beam from both sides (the front and back). The substrates were irradiated with 40 keV Ar, N, P ions. There was a strong evidence for an amorphous phase at the depth of 1400 A in the irradiated plates of monocrystalline silicon and a polycrystalline phase at the depth of 2000 A. 3 refs.

6841 (INIS-RU–379, pp. 46-48) **Calculation of ion depth distribution at axial channeling with the allowance for multiple scattering and energy loss fluctuations.** Samarin, V.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The method of multiple scattering and energy loss fluctuations at calculation of ion depth distribution in amorphous material is extended to the case of axial ion channeling. The calculations of phosphorous, aluminium and calcium ions with the energies from 50 to 400 keV at their axial channeling in silicon are in good agreement with the experimental data. 4 refs., 2 figs.

6842 (INIS-RU–379, pp. 67-69) **On the possibility of one-frequency quasicharacteristic radiation generation at coherent channeling in crystals.** Vysotskij, V.I.; Kuz'min, R.N.; Maksyuta, N.V. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A possibility of generation of quasi-characteristic radiation with only one discrete line in X-radiation spectrum is considered for the case of coherent relativistic particle (electrons) channeling with full self-suppression of other discrete and continous lines in the usual quasi-characteristic radiation spectrum. 2 refs.

6843 (INIS-RU–379, pp. 70-72) **A set of programs describing electromagnetic processes at relativistic particle motion in the periodic potential of crystal field.** Nichipor, I.V.; Feranchuk, I.D.; Ul'yanenkov, A.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged

particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

A set of programs is suggested to calculate band and radiation spectra from the Schroedinger equation with an arbitrary periodical potential defining the channeling relativistic particles (E=1-500 MeV). The program takes into account the radiation spectrum formation by summing up supbarrier, subbarier and intermediate energy-level transitions. It enables an approximate calculation of dechanneling processes. 5 refs.

6844 (INIS-RU–379, pp. 73-76) **Distortions in B-type coherent bremsstrahlung spectra of channeling relativistic electrons.** Amosov, K.Yu.; Balayan, A.S.; Vnukov, I.E.; Kalinin, B.N.; Naumenko, G.A.; Potylitsyn, A.P.; Sarychev, V.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Relations and differences between the two mechanisms of gamma quanta generation by electrons (E=100-200 MeV) in <100> diamond monocrystals: coherent bremsstrahlung (CB) and radiation at channeling are revealed. The 'splitting' in the peak of the spectrum due to electron channeling is discovered. The CB process can be used for production of quasimonochromatic photon beams. 9 refs.; 4 figs.

6845 (INIS-RU–379, pp. 77-78) **Study of positron beam production at electron channeling in tungsten.** Amosov, K.Yu.; Balayan, A.S.; Vnukov, I.E.; Kalinin, B.N.; Naumenko, G.A.; Potylitsyn, A.P.; Sarychev, V.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Spectra of positrons generated of 900 MeV electron-induced radiation in tungsten and tantalum monocrystals are measured. Because of high intensity and narrow focus of radiation at electron channeling the positron emission in the energy range 4-20 MeV for an oriented crystal is 3-4 times higher than it is for a disoriented one. With growing positron energy the yield ratio decreases up to 1 at positron energy E=80-90 MeV and it becomes less than 1 at higher energies. 6 refs.; 1 fig.

6846 (INIS-RU–379, pp. 87-89) **Diffusion of boron implanted into silicon irradiated by high-energy argon ions.** Varichenko, V.S.; Didyk, A.Yu.; Zajtsev, A.M.; Kazyuchits, N.M.; Kudelevich, N.A.; Chelyadinskij, A.R. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The diffusion of 100 keV boron ions implanted into Si irradiated by high-energy (46,3 MeV) Ar ions is investigated. Ar^+ ion implantation is shown to result in a 12 mkm surface defective layer where there is a 'plato' at the depth of 5 mkm and then defect concentration growth with the depth was seen. The absence of defect influence on the impurity re-distribution indicates the possible use of high-energy ion doping together with ion implantation at ordinary energies of ion beams within one technological cycle. 3 refs.; 3 figs.

6847 (INIS-RU–379, pp. 90-92) **Accumulation of radiation defects in silicon at high-energy ion implantation.** Varichenko, V.S.; Didyk, A.Yu.; Zajtsev, A.M.; Kazyuchits, N.M.; Mel'nikov, A.A.; Skuratov, V.A.; Chelyadinskij, A.R. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Radiation defect depth distribution in the destructed layer, defect formation and annealing in the surface layer of Si crystals implanted with 1 MeV Ne^+, Ar^+ and Kr^+ ions at room temperature are investigated. A similar picture of defect formation is shown: the defect concentration increase decrease in defect formation rate at a certain typical of each ion dose. 2 figs.

6848 (INIS-RU–379, pp. 93-95) **Defect formation in silicon irradiated by high-energy argon ions.** Azarko, I.I.; Varichenko, V.S.; Kazyuchits, N.M.; Penina, N.M.; Tolstykh, V.P. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The EPR method was used to study the peculiarities of paramagnetic defect formation in silicon irradiated by 47 MeV Ar^+ ions. Spectral analysis has shown the formation of point defects (PD) and isolated amorphous domains (AD). The formation of AD occured due to maximum accumulation of PD in the 12 mkm layer and due to the formation of AD immediately in the domain of defect accumulation. 3 refs.; 3 figs.

6849 (INIS-RU–379, pp. 96-98) **Influence of ion flux density and irradiation time on the long-range interaction effect.** Sorvina, V.P.; Tetel'baum, D.I. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The effects of irradiation time (argon 40 keV ions) and ion flux density (j) on silicon microhardness on the opposite to the irradiated side of silicon plate and, cosequently, on the behavior of defects in semiconductor's layer adjacent to the unirradiated surface were studied. Measurements were carried out under the load of 20 G. It is shown that the higher ion flux density, the more probable dislocation-type defect formation is. At small values of j microhardness on the unshielded part of the plate is lower than it is on the shielded one. At great values of j the inverse relation takes place. 3 refs.; 2 figs.

6850 (INIS-RU–379, pp. 116-117) **Structural changes in GaAs doped with selenium ions.** Kaparov, S.E.; Kudyshev, A.N. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The investigation results on structural changes in ion-doped layer of GaAs are presented. The samples were doped with 450 keV Se^+ ions. Radiation dose and temperature dependences of the formation of clusters and dislocation loops in GaAs during its annealing are reported. 6 refs.

6851 (INIS-RU–379, pp. 118-120) **The effect of size-energy factor on mass transfer at ion implantation of two-layer films.**

Shpilevskij, Eh.M.; Kurilo, I.N. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Diffusion atomic flows of the two-layer Mo-Si film at the interface and at argon ion implantation are considered. A diffusion atomic flow is determined of the size-energy parameter γ, which characterises the location of implanted ion maximum. It is shown that the γ parameter has a significant effect on mass transfer and $MoSi_2$ and $MoSi_{0.65}$ phase growth. 3 refs.; 1 fig.; 1 tab.

6852 (INIS-RU–379, pp. 121-123) **Oxygen position in silicon.** Soroka, V.I.; Artsimovich, M.V.; Mogil'nik, M.F. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The aim of the paper is to clarify the position of oxygen in silicon by using 150 keV oxygen ion axial channeling and by annealing the sample at T=750 deg C. The position of oxygen was found out from IR absorption spectrum. The Si-O interatomic distance was found to be 1.20 A with the bond angle Si-O-Si equal to 153±4 deg. 5 refs.; 2 figs.

6853 (INIS-RU–379, pp. 124-127) **The influence of defect thermal stability on ion-induced crystallization.** Gusakov, G.A.; Novikov, A.P.; Komarov, F.F.; Tolstykh, V.P.; Akimov, A.N. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Variations in the spectrum of crystal defects induced by ion beams in silicon depending on substrate temperature in the process of silicon epitaxial growth (ion-induced crystallization IIC) are investigated. The samples were bombarded by P^+ ions at E=150 keV at T=20-450 deg C. It is shown that below 120 deg C the IIC process does not take place, because due to divacancy accumulation there is amorphization of Si near the interface. Temperatures above 125 deg C prevent the formation of VV-centers. 4 refs.; 2 figs.

6854 (INIS-RU–379, pp. 140-141) **Radiation defects and thermal stability of $A^{IV}B^{VI}$ films at proton irradiation.** Freik, D.M.; Salij, Ya.P.; Ruvinskij, M.A.; Voznyak, O.M.; Gorichok, I.Ya.; Dobrovol'skaya, A.M. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

The specific features of the annealing of radiation-induced defects in $Pb_{1-x}Sn_xTe$ films irradiated by 200-400 keV protons at 300 K and annealed at 310-450 K are determined. It is found that Frenkel pairs are the main defects of the films. The electric parameters of the films are completely restored at the temperatures 360-420 K. 3 refs.; 1 fig.

6855 (INIS-RU–379, pp. 144-146) **Internuclear axis orientation effects at molecular ion dissociation in metal surface.** Balashova, L.L. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of the 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Possible effects of internuclear axis orientation in energy spectra of dissociation products are studied from the point of view of the 'electron' dissociation mechanism. The calculations are carried out for H_2^+ dissociation at ion reflection by Al surface. The main qualitative result is the evidence for line narrowing in the energy spectrum of dissociation atom-products. 5 refs.; 2 figs.

6856 (LBL–35679) **Increasing the retained dose by plasma immersion ion implantation and deposition.** Anders, A.; Anders, S.; Brown, I.G.; Yu, Kin M. Lawrence Berkeley Lab., CA (United States). 22 Jul 1994. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-940731–3: 2. international conference on computer simulation of radiation effects, Santa Barbara, CA (United States), 24-29 Jul 1994). Order Number DE95003423. Source: OSTI; NTIS; INIS; GPO Dep.

The retained dose of ions can be increased by Plasma Immersion Ion Implantation and Deposition (PIIID). A substrate is immersed in a metal or carbon plasma and a negative repetitively pulsed bias voltage is applied. During the pulses, an electric sheath is formed around the substrate and ions are accelerated through the sheath and implanted into the substrate. Direct and recoil ion implantation and sputtering take place during the pulses whereas low-energy deposition occurs between the pulses. The condensable plasma can be produced using a cathodic arc plasma source combined with a magnetic macroparticle filter. PIIID can be applied to perform fast high-dose implantations or to deposit thin films with broad intermixing at the film-substrate interface. The bias voltage duty cycle can be tuned to sputter away the film deposited during pulse off-time (similar to the method of sacrificial layer). We have simulated the PIIID process using the Monte Carlo code T-DYN 4.0. This code allows a calculation of the dose-dependent depth profile for a process with deposition and implantation phases, taking sputtering into account. Predicted retained doses and experimentally obtained retained doses measured by Rutherford backscattering spectrometry are compared.

6654 Quantum Physics Aspects of Condensed Matter

6857 (CONF-940847–4) **The effect of magnetic field on the edge plasmons of two-dimensional electron gas systems.** Xia, X. (Tennessee Univ., Knoxville, TN (United States). Dept. of Physics and Astronomy); Chen, X.M.; Quinn, J.J. Oak Ridge National Lab., TN (United States); Tennessee Univ., Knoxville, TN (United States). Dept. of Physics and Astronomy. Jul 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. From Conference on the application of high magnetic fields; Cambridge, MA (United States); 8-12 Aug 1994. Order Number DE94018044. Source: OSTI; NTIS; GPO Dep.

Edge magnetoplasmons of two-dimensional electron gas (2DEG) systems with density profiles that fall from their bulk value to zero in a non-abrupt manner are investigated. Higher multipole modes, which can be thought of as bulk plasmons of the low density edge region, exist as localized edge modes only for finite values of wavevector along the edge. In addition, a sequence of very low frequency edge magnetoplasmons displaying linear dispersion are found for only one direction of propagation along the edge for a given applied magnetic field. Some insight is gained from the analysis of a simple double step density profile.

665410 Superconductivity

Refer also to citation(s) 6409, 6597, 6822, 6823, 6824, 6825, 6828

6858 (ANL/MSD/CP–83118) **BCS-like gap structure of $HgBa_2CuO_{4+\delta}$ tunnel junctions.** Chen, J. (Argonne National Lab., IL (United States)); Zasadzinski, J.F.; Gray, K.E.; Wagner, J.L.; Hinks, D.G.; Kouznetsov, K.; Coffey, L. Argonne National Lab., IL (United States). [1994]. 5p. Sponsored by USDOE, Washington,

DC (United States);National Science Foundation, Washington, DC (United States). DOE Contract W-31109-ENG-38. NSF Contract DMR-91-20000. (CONF-941013–16: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95004125. Source: OSTI; NTIS; INIS; GPO Dep.

The authors report point-contact tunneling into polycrystalline $HgBa_2CuO_{4+\delta}$ superconductors with a T_c onset of 97 K using a superconducting Nb counterelectrode. These SIS tunnel junctions are of unusually high quality for cuprate superconductors, exhibiting low and flat sub-gap conductances and sharp conductance peaks as expected from a BCS density of states. These features are obtained reproducibly and are consistent with earlier published SIN results using an Au counterelectrode. Use of experimental data to simulate the performance of a quasiparticle mixer indicates that $HgBa_2CuO_{4+\delta}$ may be suitable for use in low noise heterodyne receivers operating at a few THz.

6859 (ANL/MSD/CP–84784) **Melting of the moving vortex lattice in the presence of disorder.** Koshelev, A.E.; Vinokur, V.M. Argonne National Lab., IL (United States). Materials Science Div. Jul 1994. 3p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940701–22: Meeting on materials and mechanisms of superconductivity: high temperature superconductors, Grenoble (France), 4-9 Jul 1994). Order Number DE95004126. Source: OSTI; NTIS; INIS; GPO Dep.

The authors investigate the melting of the two-dimensional vortex lattice moving in an inhomogeneous environment under the applied current j. They predict the existence of a dynamic phase transition at some current $j = j_t$ (crystallization current) from the motion of the amorphous configuration at $j < j_t$ to the motion of the crystal at $j > j_t$. j_t exceeds essentially the critical current j_c for strongly disordered systems and approaches j_c with the decrease of the degree of disorder. They find that j_t diverges as temperature approaches the melting temperature of the undisturbed lattice.

6860 (INIS-RU–379, pp. 49-51) **Radiation-acoustic study of a superconducting state in $YBa_2Cu_3O_7$.** Burlikov, V.L.; Vorob'ev, S.A. AN SSSR, Moscow (Russian Federation); Moskovskij Gosudarstvennyj Univ., Moscow (Russian Federation). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki. 1993. 169p. (In Russian). (CONF-9205318–: 22. Conference on physics of charged particle interaction with crystals, Moscow (Russian Federation), 25-27 May 1992). In *Proceedings of 22. international meeting on the physics of charged particle interaction with crystals.* Order Number DE95611565. Source: OSTI; NTIS (US Sales Only); INIS.

Radiation-acoustic study of a superconducting state in $YBa_2Cu_3O_7$ is carried out. Acoustic oscillations were generated by pulsed 5.7 MeV electron beams. A usual temperature-dependent variation in the acoustic signal amplitude (ASA) is noticed in the experiment. The ASA values are ranging due to variation of thermal parameters of contact lubricant. 4 refs., 2 figs.

6861 (LA-UR–94-3725) **HTS current lead using a composite heat pipe.** Daugherty, M.A.; Prenger, F.C.; Hill, D.D.; Daney, D.E.; Woloshun, K.A. Los Alamos National Lab., NM (United States). [1995]. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941013–14: Applied superconductivity conference, Boston, MA (United States), 16-21 Oct 1994). Order Number DE95003718. Source: OSTI; NTIS; GPO Dep.

This paper discusses the design and fabrication of HTS current leads being built by Los Alamos to supply power to a demonstration HTS coil which will operate in a vacuum cooled by a cryocooler. Because vapor cooling is not an option for this application the leads must be entirely conductively cooled. In the design of HTS current leads for this type of application, it is desirable to intercept part of the heat load at an intermediate temperature. This thermal intercept or connection must be electrically insulating but thermally conductive, two mutually exclusive properties of most candidate solid materials. To achieve this end we incorporate a composite nitrogen heat pipe, constructed of conducting and non-conducting materials, to provide efficient thermal communication and simultaneously, electrical isolation between the lead and the intermediate temperature heat sink. Another important feature of the current lead design is the use of high Jc thick film superconductors deposited on a non-conducting substrate to reduce the conductive heat leak through the lower portion of the lead. Two flexible electrical conductors are incorporated to accommodate handling, assembly and the dissimilar expansion coefficients of the various materials.

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Refer also to citation(s) 6911, 6912, 6913, 6914, 6915, 6916, 6917, 6918, 6919, 6920, 6921, 6922, 6923, 6924, 6925, 6926, 6927, 6928, 6929, 6930, 6931

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Refer also to citation(s) 6938

6862 (CIEMAT–738) **Setting-up of the Laser Induced Fluorescence diagnostic. Measurements of Cr density in a neon glow discharge.** Tafalla, D.; Cal, E. de la; Tabares, F.L. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 20p. (In Spanish). Order Number DE95721647. Source: OSTI; NTIS; INIS.

A plasma diagnostic based on the Laser Induced Fluorescence (LIF) technique has been set up in the Fusion Division at the CIEMAT. In a preliminary experiment, The density of sputtered chromium atoms produced in a neon glow discharge was measured. Firstly, the laser beam was characterized by calibration of its wavelength bandwidth and energy profile and Rayleigh scattering in N_2 was used for the optical system calibration. An absolute density of Cr atoms of n= 5x10^9 cm^-3 was obtained in discharges at 100 mA and pressure of 15 mTorr and a linear dependence of the LIF signal US. current was found. These values are in agreement with those expected from the tabulated sputtering yields and the thermalization and diffusion of the sputtered atoms into the Ne plasma.

6863 (CIEMAT–739) **Plasma diagnostics for tokamaks and stellarators.** Stott, P.E.; Sanchez, J. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 321p. Order Number DE95722411. Source: OSTI; NTIS; INIS.

A collection of papers on plasma diagnostics is presented. The papers show the state of the art developments in a series of techniques: magnetic diagnostics, Edge diagnostics, Langmuir probes, Spectroscopy, Microwave and FIR diagnostics as well as Thomson Sattering. Special interest was focused on those diagnostics oriented to fluctuations measurements in the plasma.

6864 (DOE/ER/53173–T3) **[Fluctuations and transport in fusion plasma].** California Inst. of Tech., Pasadena, CA (United States). [1989]. 23p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-84ER53173. Order Number DE95004177. Source: OSTI; NTIS; GPO Dep.

This research is aimed at furthering the understanding of turbulent fluctuations in fusion plasmas and the anomalous transport of particles, heat, and momentum which results therefrom. This understanding is critical to the design of future plasma confinement devices. This study involves a combination of experimental measurements, from the Caltech and other tokamaks, analysis and interpretation of measurements, computer calculations of basic processes, and comparisons of the latter with experiment.

6865 (DOE/ER/53173–T4) **[Fluctuations and transport in fusion plasma]: Progress report, October 1, 1989–September 30, 1990.** California Inst. of Tech., Pasadena, CA (United States). [1995]. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG03-84ER53173. Order Number DE95004178. Source: OSTI; NTIS; INIS; GPO Dep.

In the study of plasma collection by obstacles in a tokamak edge plasma, the effect of anomalous transport have been examined using an extension of the 2D fluid code developed here previously (Appendices A and B). The origin of the anomalous transport is assumed to be a randomly fluctuating electric field such as would be caused by drift waves. As before, the magnetic field is assumed to be uniform and perpendicular to the obstacle, which is taken to be an infinite strip. In the absence of ambient plasma flow, the numerical results indicate that ion viscous heating is important near the tip of the obstacle, where there is a large velocity gradient in the

flow. For typical plasma parameters, the maximum ion temperature near the tip is up to 85% higher than the ambient ion temperature. When there is a subsonic plasma flow past the obstacle, the numerical results indicate that, near the tip of the obstacle, the ions on the downstream side are hotter than those on the upstream side. Furthermore, the ion density is higher on the upstream side. A detailed report of this work has been prepared and will be submitted as part of the Annual Progress Report. Recently, the 2D parallel electrostatic plasma particle-in-cell (PIC) code described in reference (9) (Appendix B) has been upgraded to a 2D fully electromagnetic PIC code. This code has been successfully tested on the JPL/Caltech Mark III Hypercube concurrent computers and can be used to simulate interactions of electromagnetic waves with a magnetized plasma. It is currently applied to investigate the decay of large amplitude Alfven waves, such as those observed in the solar wind. Large amplitude Alfven waves, propagating parallel to the magnetic field, are predicted to decay into obliquely propagating daughter waves and standing magnetosonic waves. Results from the simulations will be compared with theoretical predictions.

6866 (DOE/ER/53198–251) **Generation of fast electrons in reversed field pinches by the equilibrium grad |B| force.** Fiksel, G. Wisconsin Univ., Madison, WI (United States). Plasma Physics Research. Oct 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG02-85ER53198. Order Number DE95004467. Source: OSTI; NTIS; INIS; GPO Dep.

It is shown that a decreasing magnetic field profile in reversed-field pinch plasmas leads to formation of an anisotropic electron distribution function at the plasma edge. The mechanism is the conservation of the magnetic moment and the energy of electrons that collisionlessly travel outward in a stochastic magnetic field. As a result, the electrons have high parallel energies and low perpendicular energies at the edge. The details of the distribution function correspond well to experimental results.

6867 (DOE/ER/53266–48) **Transport suppression by diamagnetic phase shift as a possible mechanism to the L to H transition.** Isichenko, M.B. (Univ. of Texas, Austin, TX (United States). Fusion Research Center); Diamond, P.H. Texas Univ., Austin, TX (United States). Fusion Research Center; Texas Univ., Austin, TX (United States). 28 Sep 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-88ER53266 ; FG03-94ER54241. (FRCR–451). Order Number DE95003345. Source: OSTI; NTIS; INIS; GPO Dep.

In the presence of a pressure gradient, the phase velocity of drift-wave or ITG-mode turbulence is different from the poloidal E×B rotation velocity of guiding centers. This results in an E×B turbulent particle diffusion being suppressed by the phase shift due to the diamagnetic rotation velocity v_θ = (c/enB)dP/dr. This shift cannot be eliminated by a frame change and affects the plasma transport. For v_θ well above the turbulent velocity $v = -c\nabla\phi\times B/B^2$, the radial diffusivity is suppressed as $D \propto v_\theta^{-3}$. This results in a non-monotonous particle flux $\Gamma(\nabla n) \simeq -D_0\nabla n[1+\alpha(\nabla n)^2]^{3/2}$ such as the transport can develop a bifurcation at a realistic density gradient.

6868 (DOE/ET/53088–671) **Energetic particle drive for toroidicity-induced Alfven eigenmodes and kinetic toroidicity-induced Alfven eigenmodes in a low-shear Tokamak. Revised.** Breizman, B.N. (Univ. of Texas, Austin, TX (United States). Inst. for Fusion Studies); Sharapov, S.E. Texas Univ., Austin, TX (United States). Inst. for Fusion Studies. Oct 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-80ET53088. (IFSR–671). Order Number DE95003222. Source: OSTI; NTIS; INIS; GPO Dep.

The structure of toroidicity-induced Alfven eigenmodes (TAE) and kinetic TAE (KTAE) with large mode numbers is analyzed and the linear power transfer from energetic particles to these modes is calculated in the low shear limit when each mode is localized near a single gap within an interval whose total width Δ^{out} is much smaller than the radius r_m of the mode location. Near its peak where most of the mode energy is concentrated, the mode has an inner scalelength Δ^{in}, which is much smaller than Δ^{out}. The scale Δ^{in} is determined by toroidicity and kinetic effects, which eliminate the singularity of the potential at the resonant surface. This work examines the case when the drift orbit width of energetic particles Δ_b is much larger than the inner scalelength Δ^{in}, but arbitrary compared to the total width of the mode. It is shown that the particle-to-wave linear power transfer is comparable for the TAE and KTAE modes in this case. The ratio of the energetic particle contributions to the growth rates of the TAE and KTAE modes is then roughly equal to the inverse ratio of the mode energies. It is found that, in the low shear limit the growth rate of the KTAE modes can be larger than that for the TAE modes.

6869 (GA-A–21799) **q Profile evolution and enhanced core confinement of high β_p plasmas in DIII-D.** Stallard, B.W. (Lawrence Livermore National Lab., CA (United States)); Casper, T.A.; Fenstermacher, M.E. General Atomics, San Diego, CA (United States); Lawrence Livermore National Lab., CA (United States). Oct 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; W-7405-ENG-48. (IAEA-CN–60/A3/5-P-11; CONF-940994–3: 15. international conference on plasma physics and controlled nuclear fusion research, Madrid (Spain), 26 Sep - 1 oct 1994). Order Number DE95003878. Source: OSTI; NTIS; INIS; GPO Dep.

In DIII-D the authors have investigated the long pulse evolution of high poloidal beta ($_{betap}$), double-null diverted H-mode discharges, which exhibit high bootstrap current fractions attractive for a reactor. At low currents I_p, the current profile evolved over several seconds and the on-axis safety factor (q_0) increased. When q_0 increased above ~2, the MHD character changed from an m/n = 2/1 to an m/n = 3/1 internal kink mode, where m(n) are poloidal (toroidal) mode numbers, which then disappeared with further increases in q_0. Coincident with a strong reduction of fluctuations, the authors observed enhanced core confinement, leading to strong density peaking, a further rise in β_p, and a bootstrap current increasing to $I_{boot}/I_p \approx 0.8$, peaked within the core. Ideal MHD calculations showed access to second stability during the density rise. During the enhanced performance phase core particle lifetime (τ_p) and global energy lifetime (τ_E) increased by factors of 2 and 1.2 respectively. Transport analysis showed that core particle and thermal diffusivities D_e and χ_{eff} approached neoclassical values. During the low current experiments, large losses of fast ions (typically ~50% at 0.4 MA) were observed; at higher currents these losses are much smaller. The authors have also investigated discharges with current rampdown to high β_p. For a 5 to 6 τ_E duration following rampdown, enhanced values of β_p, normalized toroidal beta (β_N), and τ_E were obtained at high internal inductance (l_i). During both the ramp and the high confinement phases, fast ion losses were low (~10%). The loss then increased, correlated with an increase in the anisotropy ratio of perpendicular and parallel plasma pressure that suggests a fast ion loss mechanism coupled to the fast ion parallel energy.

6870 (GA-A–21811) **Experimental aspects of effects of high-energy particles on Alfven modes.** Heidbrink, W.W. General Atomics, San Diego, CA (United States). Oct 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (CONF-9408176–3: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). Order Number DE95003383. Source: OSTI; NTIS; INIS; GPO Dep.

Global Alfven modes are observed in a number of tokamaks, including DIII-D and TFTR. Instabilities occur during neutral-beam injection and during fast-wave ICRF heating, and may recently have been observed during alpha-particle heating. Identification of toroidicity-induced Alfven eigenmodes (TAE) is based primarily on the scaling of the real frequency of the mode. Other modes, including the beta-induced Alfven eigenmode (BAE), are also observed. The stability threshold of TAE modes agree (to within a factor of two) with theoretical predictions. Toroidal mode numbers of n = 2-6 are usually most unstable, as theoretically expected. Measurements of the poloidal and radial mode structure are consistent with theoretical predictions, but the uncertainties are large. Both TAE and BAE modes can cause large, concentrated losses of fast ions. Phenomenologically, beam-driven Alfven modes usually "saturate" through bursts that expel beam ions, while modes observed during ICPF heating approach a steady saturation amplitude.

6871 (GA-A–21839) **Engineering and design of a CO_2 phase contrast interferometer system for DIII-D.** Phelps, R.D.

(General Atomics, San Diego, CA (United States)); Coda, S. General Atomics, San Diego, CA (United States). Nov 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. Order Number DE95004249. Source: OSTI; NTIS; INIS; GPO Dep.

This report describes the development of a CO_2 laser interferometer system, the engineering, design and installation of the hardware, and the selection of materials specific to the requirements of a CO_2 laser diagnostic. A brief description of system operation is included. A phase contrast interferometer diagnostic has been designed and installed on the DIII-D tokamak to enhance studies of the physical characteristics of plasma turbulence, and specifically to analyze plasma density fluctuations in the boundary region of the plasma. A 20 watt CO_2 laser beam, operating at the 10.6 micron wavelength, is expanded to a diameter of 76 mm and directed through a series of mirrors which provide for entry of the beam into the vessel at a point 70 cm above the midplane at the 285 degree toroidal location. After being reflected from a mirror inside the vessel, the beam is directed downward so that it passes through the edge of the plasma immediately in front of a four-strap fast wave current drive rf antenna. The laser beam is then reflected by a second internal mirror and exits the vessel 70 cm below the midplane (also at 285 degrees) returning to an optical table through a final series of external steering mirrors.

6872 (GA-A–21847) **Transport simulation of negative magnetic shear discharges.** St. John, H.; Taylor, T.S.; Lin-Liu, Y.R.; Turnbull, A.D. General Atomics, San Diego, CA (United States). Oct 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114. (IAEA-CN–60/D-D-II-8; CONF-940933–20: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003941. Source: OSTI; NTIS; INIS; GPO Dep.

In the present work the authors present simulations which show that the hollow current profile can be maintained in quasi-steady state through a self-consistently determined combination of bootstrap current and neutral beam and rf current drive. Controllability of the q profile is demonstrated by eliminating low m/n mode number instabilities from these discharges by maintaining $q > 1.5$ at all times, starting from appropriate initial conditions. At moderately high β_p, the bootstrap current can be a substantial fraction of the total current and the ability to maintain the proper total current density profile depends on the bootstrap current profile and the availability of suitable localized heating and current drive. In these simulations, they use electron cyclotron heating, ion cyclotron heating, and electron cyclotron and fast wave current drive. The ability to maintain the profiles is demonstrated using several energy transport models. Self-consistent transport simulations are used to model the SSC discharges using the ONETWO transport code coupled to rf heating and current drive packages FASTWAVE and TORAY. To accurately model inductive and driven current profile evolution, the additional source terms that arise in Faraday's law due to internal flux surface motion are included by coupling the transport calculations to a fixed boundary equilibrium code. To test the sensitivity of the results to the transport model used, they model DIII-D discharges using thermal conductivities consistent with improved confinement DIII-D discharges, and with the Rebut-Lallia-Watkins model of energy transport.

6873 (JAERI-Research–94-001) **Transport studies of tokamak plasmas in JT-60 device.** Shirai, Hiroshi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment). Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 257p. Order Number DE95737227. Source: OSTI; NTIS; INIS.

In order to study the magnetic flux exchange at the sawtooth crash, the nonlinear evolution of the tearing mode with poloidal mode number m=1 and toroidal mode number n=1 in the presence of two or three resonant surfaces satisfying q=m/n=1 is examined. It is clarified that whether the local magnetic flux exchange or the internal disruption occurs depends on the initial profile of helical flux function ϕ_0. Light impurities such as carbon and oxygen and metal impurities such as titanium and molybdenum cause dominant radiation loss in the high density regime and give rise to major disruption. Increasing density by gas puffing while keeping the impurity content constant, the density limit of ohmically heated plasmas is studied. The numerically obtained operational diagram or Hugill diagram, qualitatively agrees well with that obtained in the experiment. Characteristics of global parameter dependence of JT-60 plasmas in both ohmic heating phase and neutral beam heating phase have been studied by using the models of electron and ion thermal diffusivities, χ_e and χ_i. The predicted T_e profile and the energy confinement time, τ_E, show good agreement with experimental data in the medium line for both ohmic heating and neutral beam heating phase. The power degradation of energy confinement time ($\tau_E{}^{th} \propto P_{abs}{}^{-1/2}$) is also reproduced. Ion temperature profiles of neutral beam heated phase of JT-60 have been simulated by using a χ_i model based on η_i mode turbulence and the drift wave turbulence. In case of TFTR L-mode plasmas, the simulated T_i profiles become flatter than experimental data. In the high T_i plasmas of JT-60 and supershot plasmas of TFTR, the predicted T_i profiles become broader compared with the experimental results. (J.P.N.).

6874 (JAERI-Research–94-011) **Onset of ELMs in JT-60U.** Kamada, Yutaka (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Sato, Masayasu; Kikuchi, Mitsuru; Mori, Masahiro. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 22p. Order Number DE95737209. Source: OSTI; NTIS; INIS.

The ELMs limiting the energy confinement in JT-60U appear when the heating power is high enough compared to the threshold power for the L-H transition. The ELM-free phase is observed when n-bar_e is lower than the threshold density $\text{n-bar}_e{}^{th}$. The threshold density $\text{n-bar}_e{}^{th}$ increases with $(B_t{}^2/(Rq_{eff}{}^2))_l$ which is a measure parameter for the ballooning stability, where q_{eff} is the effective safety factor at the edge. The edge pressure gradient estimated by $\text{n-bar}_e{}^{th}$ T_i (95%)/(T_i (95%)$^{0.5}$/B_p (a)) is proportional to $(B_t{}^2/(Rq_{eff}{}^2))_l$ which allows us to understand that the ELMs are related to the ballooning instability. A time dependent analysis of the evolution of pressure and current profiles including the boot-strap current shows that the steep edge pressure gradient is close to the marginal value for the high-n ideal ballooning instability at the onset of ELMs. (author).

6875 (JAERI-Research–94-013) **Stability analysis of external kink mode for ITER L-mode profile plasmas.** Tokuda, Shinji (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Ozeki, Takahisa. Japan Atomic Energy Research Inst., Tokyo (Japan). Sep 1994. 21p. Order Number DE95737207. Source: OSTI; NTIS; INIS.

A stability analysis is made for the n=1 external kink mode (n: toroidal mode number) to the predicted ITER L-mode profiles. The beta limit (g_T) for this kink mode is sufficiently higher than the design value of g_T=2.0-2.4 for the L-mode profiles in case of the assumed current profile even with a finite but small edge current. However, in case of q_0 less than unity (q_0: safety factor on the magnetic axis) the beta limit for the kink mode is significantly reduced: g_T is 1.0 for q_0=0.8 without a conducting wall. A conducting wall located near the mid-plane has a stronger stabilizing effect than a wall located near the null point. (author).

6876 (LA-UR–94-3664) **Tritium transport, influx, and helium ash measurements on TFTR during DT operation.** Efthimion, P.C. (Princeton Univ., NJ (United States). Plasma Physics Lab.); Johnson, L.C.; Skinner, C.H. Los Alamos National Lab., NM (United States). [1994]. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-940933–18: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003708. Source: OSTI; NTIS; INIS; GPO Dep.

The evolution of the tritium density profile is inferred from 14.1 MeV t(d,n)α and 2.5 MeV d(d,n)^{3}He neutron emissivity profiles measured in a deuterium neutral beam heated plasma into which a small amount of tritium gas has been puffed. For the first time, hydrogenic ion transport coefficients in the form of a diffusivity and convective velocity are determined. The particle diffusivities of tritium and ^{4}He, and the deuterium thermal diffusivity are of similar

magnitudes, and thus are consistent with theoretically calculated ExB drift transport. The first measurements of helium ash have been made using charge exchange recombination spectroscopy (CHERS). The measured radial ash profile shape is consistent with that predicted from simulations that include calculations of the central alpha ash source and thermal ash transport. This suggests that ash transport in the plasma core will not be a fundamental limiting factor in determining helium exhaust rates in a reactor. The authors also report the first spectroscopic measurements of tritium Balmer-alpha emission which provided a measure of tritium influx from the limiter. Tritium influx persists in discharges subsequent to tritium neutral beam injection, decaying with an initial decay of 7.5 discharges, and followed by a long term decay on the order of 400 discharges. Tritium transport, influx, and helium ash transport are important issues concerning profile control, retention, and ash removal for future reactors, like ITER.

6877 (LRP–499/94) **A direct Poisson solver for Particle-In-Cell (PIC) simulation.** Tran, T.M. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Appert, K.; Sauter, O. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. 12p. Order Number DE95611643. Source: OSTI; NTIS; INIS.

A direct Poisson solver, based on the isoparametric finite element discretization and a domain decomposition technique, is described. A simple parallelization scheme is proposed and evaluated on a 128 processor Cray T3D. (author) 4 figs., 2 tabs., 8 refs.

6878 (LRP–500/94) **Global marginal stability of TAEs in the presence of fast ions.** Villard, L. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Brunner, S.; Vaclavik, J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. 48p. Order Number DE95611650. Source: OSTI; NTIS; INIS.

The global stability of toroidicity-induced Alfven eigenmodes (TAEs) in the presence of fast ions in realistic tokamak fusion-grade plasmas is analyzed with a global, perturbative approach. Volume averaged fast particle betas for marginal stability are obtained and analyzed for a wide range of plasma parameters such as the fast ion radial density profile width, the ratio of birth velocity to the Alfven velocity on axis and the bulk plasma beta. The different stability behaviour of two types of TAEs ('internal' or 'external') is evidenced. (author) 19 figs., 22 refs.

6879 (LRP–501/94) **ELM control during double-null Ohmic H-modes in TCV.** Dutch, M.J. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Hofmann, F.; Duval, B.P.; Hirt, A.; Joye, B.; Lister, J.B.; Martin, Y.; Nieswald, C.; Pochelon, A.; Weisen, H. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. 11p. Order Number DE95611651. Source: OSTI; NTIS; INIS.

Precise control of the shape and position of Double-Null divertor configurations in the TCV tokamak has been used to reliably trigger the transition from ELM-free to ELMy Ohmic H-Mode and back. Pre-programmed modulation of the magnetic axis height, with fixed shaping field, caused the plasma to evolve, during a single discharge, between Double-Null-Upper, Double-Null and Double-Null-Lower configurations, with both X-points remaining close to the last closed flux surface. The transition from ELM-free to ELMy and back again was observed to be synchronous with the configuration modifications. Using this method, several ELM-free and ELMy phases enabled reproducible disruption-free H-mode discharges in TCV lasting up to 1.5 seconds. The plasma density during a long-duration H-mode was directly controlled by feeding back onto the vertical height of the magnetic axis. (author) 4 figs., 18 refs.

6880 (LRP–502/94) **Stabilization of ideal modes by resistive walls in tokamaks with plasma rotation and its effect on the beta limit.** Ward, D.J. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Bondeson, A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. [41p.] Order Number DE95611652. Source: OSTI; NTIS; INIS.

It is shown that pressure-driven, ideal external modes in tokamaks can be fully stabilized by resistive walls when the plasma rotates at some fraction of the sound speed. For wall stabilized plasmas, there are two types of potentially unstable external modes: those which are nearly locked to the wall and those which rotate with the plasma. For the modes rotating with the plasma, the stabilizing effect of the wall increases when the wall is brought closer to the plasma, while, for the wall-locked modes, the stabilization improves with increasing wall distance. When the plasma rotates at some fraction of the sound speed, there is a window of stability to both the wall-locked and the rotating mode. This window closes when beta exceeds a new limit which can be significantly higher than the wall-at-infinity limit. The stabilization depends principally on the toroidal coupling to sound waves and is affected by ion Landau damping. Two dimensional stability calculations are presented to evaluate the gains in beta limit resulting from this wall stabilization for different equilibria and rotation speeds. In particular, results are shown for advanced tokamak configurations with bootstrap fractions of $\simeq$ 100%. (author) 14 figs., 25 refs.

6881 (LRP–503/94) **Invited and contributed papers presented at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas".** Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. 50p. (CONF-9408176–: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). Order Number DE95611644. Source: OSTI; NTIS; INIS.

The report contains 5 invited or contributed papers presented by members of the theory group du CRPP at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas". figs., tabs., refs.

6882 (LRP–503/94, pp. 1-16) **Theoretical aspects of effects of high-energy particles on MHD modes.** Villard, L. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Brunner, S.; Vaclavik, J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. (CONF-9408176–: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). In *Invited and contributed papers presented at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas".* 50p. Order Number DE95611644. Source: OSTI; NTIS; INIS.

In this paper we adopt a global approach. The TAEs are computed globally in true toroidal geometry consistent with an ideal MHD equilibrium. Kinetic effects (damping and driving mechanisms) and fast particles are treated perturbatively. More precisely, we first obtain the global eigenmodes an then use these given eigenmode fields to evaluate the global overall wave-particle power transfer assuming given fast particle density profiles. The marginal stability point is obtained by scaling the number of fast particles so that the overall power transfer is zero. The wave-particle power transfers are evaluated using the drift-kinetic equations. The paper is structured as follows: In section two, the plasma model in toroidal geometry is briefly presented. The expressions for the DKE powers are derived for the various species in the companion paper in these proceedings. In section 3 we show the results of our model applied to a wide variety of plasma parameters. In particular, the critical volume-averaged fast particle beta corresponding to marginal stability, $<\beta_f>_\alpha$, is calculated for a wide range of bulk plasma parameters and fast particle profile widths. We discuss the results in section 4 and draw some conclusions in section 5.(author) 13 figs., 21 refs.

6883 (LRP–503/94, pp. 17-24) **Nonlinear interaction of lower hybrid waves.** Bruderer, C. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Vaclavik, J.; Appert, K. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. (CONF-9408176–: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). In *Invited and contributed papers presented at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas".* 50p. Order Number DE95611644. Source: OSTI; NTIS; INIS.

A 3D nonlinear wave code including quasilinear evolution of the electron distribution functions has been developed. We have shown that nonlinear interactions are able to fill in the spectral gap. In the results shown, the power input is very high, because the collision frequency has been arbitrarily raised in order to run the case in reasonable computational times. A faster converging time evolution numerical scheme has to be implemented. (author) 5 figs., 6 refs.

6884 (LRP–503/94, pp. 25-30) **A kinetic model for the global power transfer between particles and MHD waves.** Brunner, S. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Villard, L.; Vaclavik, J. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. (CONF-9408176–: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). In *Invited and contributed papers presented at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas".* 50p. Order Number DE95611644. Source: OSTI; NTIS; INIS.

We present here the calculations that lead to the power absorption formulas used in the companion paper in the study of possible destabilization of Alfven modes by high-energy ions. (author) 4 refs.

6885 (LRP–503/94, pp. 31-39) **Linear wave propagation in resistive/hot tokamak plasmas.** Jaun, A. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Appert, K.; Vaclavik, J.; Villard, L.; Luetjens, H. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. (CONF-9408176–: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). In *Invited and contributed papers presented at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas".* 50p. Order Number DE95611644. Source: OSTI; NTIS; INIS.

Using the bicubic finite element codes CHEASE and PENN, Maxwell's equations are solved for global wavefields in a realistic tokamak equilibrium. Two different models have been implemented to calculate the linear response of the plasma: a cold resistive model which gives results in good agreement with the cold toroidal code LION in the case of TAE mode computations. The second is a hot kinetic model, which is validated with the hot cylindrical code ISMENE, reproducing the mode conversion to a kinetic Alfven wave in the large aspect ratio limit. Using the new tool for a preliminary study, self-consistent (non-perturbative) calculations of TAE mode wavefields show how finite Larmor radius effects can couple a gap mode to the kinetic Alfven wave, resulting in a radiatively damped KTAE mode. (author) 5 figs., 9 refs.

6886 (LRP–503/94, pp. 41-48) **3-D Fokker-Planck code valid for arbitrary collisionality and adjoint function for bootstrap current calculation.** Sauter, O. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Vaclavik, J.; Lin-Liu, Y.R.; Hinton, F.L. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. (CONF-9408176–: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). In *Invited and contributed papers presented at the joint Varenna-Lausanne international workshop on "theory of fusion plasmas".* 50p. Order Number DE95611644. Source: OSTI; NTIS; INIS.

We have developed a 3-D code, $CQL_{//}$, which solves the drift-kinetic Fokker-Planck equation along the magnetic field line on a given flux surface. It is 2-D in velocity space and 1-D spatially along B. Therefore no bounce-averaging is performed and the model is valid for arbitrary collisionality and axisymmetric tokamak equilibria. The adjoint function formalism has been adapted to calculate the neoclassical bootstrap current, assuming small banana width compared with the minor radius. We compare the results of our code with published analytical formulae and with the results of the modified bounce-averaged code CQL3D. (author) 4 figs., 12 refs.

6887 (LRP–505/94) **Electron cyclotron resonance heating.** Pochelon, A. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)). Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. 20p. Order Number DE95611665. Source: OSTI; NTIS; INIS.

With the availability of high frequency ($f \geq 50$ GHz) high power microwave sources, Electron Cyclotron Resonance Heating (ECRH) is widely used in present-day tokamaks and stellarators and is planned for applications in ITER (International Thermonuclear Experimental Reactor). ECRH can be used over a broad spectrum of applications ranging from heating, with the aim of increasing plasma temperature and pressure, to plasma profile tailoring, in particular current profile tailoring, with the aim of enhancing or optimising stability and confinement properties. The presentation is structured as follows: the first points to be discussed when considering ECRH are accessibility and absorption, although it will be seen that it is not easy to separate one from the other due to the links between absorption and propagation. Some examples of the use of ECRH as a tool for different physics applications in tokamaks will be addressed. The applications envisioned for the Next Step (ITER) and for the Reactor will be the subject of the last chapter. (author) 16 figs., 3 tabs., 28 refs.

6888 (LRP–506/94) **Spatio-temporal powder formation and trapping in RF silane plasmas using 2-D polarization-sensitive laser scattering.** Dorier, J.L. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Hollenstein, C.; Howling, A.A. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Sep 1994. 20p. Order Number DE95611671. Source: OSTI; NTIS; INIS.

Contributed paper to the 41. National Symposium of the American Vacuum Society, Denver, 24-28 October 1994.

Powder formation studies in deposition plasmas are motivated by the need to reduce contamination in the plasma and films. Models for the force acting upon particles in rf discharges suffer from a lack of quantitative experimental data for comparison in the case of silane-containing plasmas. In this work, a cross-section of the parallel-plate capacitor discharge is illuminated with a polarized beam-expanded laser and global spatio-temporal scattered light and extinction are recorded by CCD cameras. Spatially-regular periodic bright/dark zones due to constructive/destructive Mie interference are visible over large regions of the powder layers, which shows the uniform nature of particle growth in silane plasmas. For particles trapped in an argon plasma, as for steady-state conditions in silane, spatial size segregation is demonstrated by fringes which reverse according to the polarisation of scattered light. The method allow a self-consistent estimation of particle size and number density throughout the discharge volume from which strong particle Coulomb coupling ($\Gamma > 40$) is suggested to influence powder dynamics. Correction must be made to the plasma emission profile for the extinction by powder. In conclusion, this global diagnostics improves understanding of particle growth and dynamics in silane rf discharges and provides experimental input for testing the validity of models. (author) 6 figs., 43 refs.

6889 (LRP–507/94) **Reconstruction of the time-averaged sheath potential profile in an argon RF plasma using the ion energy distribution.** Fivaz, M. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Brunner, S.; Schwarzenbach, W.; Howling, A.A.; Hollenstein, C. Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Oct 1994. 18p. Order Number DE95611639. Source: OSTI; NTIS; INIS.

Charge-exchange collisions and radio-frequency excitation combine to give peaks in the ion energy distribution measured at the ground electrode of an argon plasma in a capacitive reactor. These peaks are used as a diagnostic to reconstruct the profile of the time-averaged potential in the sheath. Particle-In-Cell simulations show that the method is accurate. The method is applied to investigate the sheath thickness as a function of excitation frequency at constant plasma power. The time-averaged potential is found to be parabolic in both experimental measurements and numerical simulation. (author) 6 figs., 1 tab., 15 refs.

6890 (LRP–508/94) **Alfven wave heating and stability.** Villard, L. (Ecole Polytechnique Federale, Lausanne (Switzerland). Centre de Recherche en Physique des Plasma (CRPP)); Brunner, S.; Jaun, A.; Vaclavik, J. Ecole Polytechnique Federale, Lausanne

(Switzerland). Centre de Recherche en Physique des Plasma (CRPP). Oct 1994. 33p. Order Number DE95611653. Source: OSTI; NTIS; INIS.

Preprint of an invited talk given at the International Workshop on Alfven Waves in Honor of Prof. Hannes Alfven, Rio de Janeiro, Brazil, 8-10 November, 1994.

Alfven waves in fusion plasmas play an important role in a number of situations. First, in Alfven Wave Heating (AWH) schemes. Second, both theory and experiment have demonstrated the existence of Global Alfven Eigenmodes (GAEs). GAEs have been observed in different tokamaks (PRETEXT, TCA, TEXTOR, etc.) and, more recently, in a stellarator (Wendelstein 7-AS) where they were shown to become unstable under intense Neutral Beam injection. Third, the existence and possible destabilization by fast ions of Toroidicity induced Alfven Eigenmodes (TAEs) has been evidenced both theoretically and experimentally. This destabilization could hamper the operation of a magnetically confined fusion reactor by setting a limit on the number of fusion alpha particles in the plasma. It is therefore crucial to understand the mechanisms leading to the occurrence of the instability and also those that can stabilize the TAEs by increasing the strength of the damping. The aim is to be able to devise possible ways to avoid the instability of Alfven eigenmodes in a region of parameter space that is compatible with the functioning of a fusion reactor. A global perturbative approach is presented to tackle the problem of the linear stability of TAEs. Our model computes the overall wave particle power transfers to the different species and thus could also be applied to the study of alpha power extraction in the presence of Alfven waves. We indicate also how to go beyond the perturbative approach. (author) 15 figs., 38 refs.

6891 (UCRL-ID–117110) **Lower hybrid current drive for edge current density modification in DIII-D: Final status report.** Fenstermacher, M.E. (Lawrence Livermore National Lab., CA (United States)); Porkolab, M. Lawrence Livermore National Lab., CA (United States). 4 Aug 1993. 52p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95004195. Source: OSTI; NTIS; INIS; GPO Dep.

Application of Lower Hybrid (LH) Current Drive (CD) in the DIII-D tokamak has been studied at LLNL, off and on, for several years. The latest effort began in February 1992 in response to a letter from ASDEX indicating that the 2.45 GHz, 3 MW system there was available to be used on another device. An initial assessment of the possible uses for such a system on DIII-D was made and documented in September 1992. Multiple meetings with GA personnel and members of the LH community nationwide have occurred since that time. The work continued through the submission of the 1995 Field Work Proposals in March 1993 and was then put on hold due to budget limitations. The purpose of this document is to record the status of the work in such a way that it could fairly easily be restarted at a future date. This document will take the form of a collection of Appendices giving both background and the latest results from the FY 1993 work, connected by brief descriptive text. Section 2 will describe the final workshop on LHCD in DIII-D held at GA in February 1993. This was an open meeting with attendees from GA, LLNL, MIT and PPPL. Summary documents from the meeting and subsequent papers describing the results will be included in Appendices. Section 3 will describe the status of work on the use of low frequency (2.45 GHZ) LH power and Parametric Decay Instabilities (PDI) for the special case of high dielectric in the edge regions of the DIII-D plasma. This was one of the critical issues identified at the workshop. Other potential issues for LHCD in the DIII-D scenarios are: (1) damping of the waves on fast ions from neutral beam injection, (2) runaway electrons in the low density edge plasma, (3) the validity of the WKB approximation used in the ray-tracing models in the steep edge density gradients.

6892 (UCRL-JC–117113) **Gyrokinetic and global fluid simulations of tokamak microturbulence and transport.** Dimits, A.M.; Byers, J.A.; Williams, T.J.; Cohen, B.I.; Xu, W.Q.; Cohen, R.H.; Crotinger, J.A.; Shestakov, A.I. Lawrence Livermore National Lab., CA (United States). 30 Aug 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940933–17: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003628. Source: OSTI; NTIS; INIS; GPO Dep.

Results are presented from the first systematic nonlinear kinetic simulation study of the swings and parameter dependences of toroidal ion-temperature-gradient (ITG) turbulence and transport, and from the first such study that includes sheared toroidal flows. Key results include the observation of clear gyroBohm scaling of the turbulent transport and of a surprisingly weak dependence of the transport on toroidal flow shear. Based on the simulation results, a parameterization of the transport is given that includes the dependence on all of the relevant physical parameters. The transition from local to nonlocal transport as a function of the profile scale length has been investigated using two-dimensional global fluid simulations of dissipative drift-wave turbulence. Local gyroBohm scaling is observed, except at very short profile scale lengths.

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Refer also to citation(s) 6869, 6876, 6958

6893 (ANL/CMT/CP–84818) **Ab initio calculations for dissociative hydrogen adsorption on lithium oxide surfaces.** Sutjianto, A. (Argonne National Lab., IL (United States). Chemical Technology Div.); Tam, S.W.; Curtiss, L.A.; Johnson, C.E.; Pandey, R. Argonne National Lab., IL (United States). Chemical Technology Div. [1994]. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-31109-ENG-38. (CONF-940416–31: 96. annual meeting of the American Ceramic Society (ACS), Indianapolis, IN (United States), 25-28 Apr 1994). Order Number DE95004130. Source: OSTI; NTIS; INIS; GPO Dep.

Lithium ceramics are one class of materials being considered as tritium breeders for fusion technology,and hydrogen is known to enhance the release of tritium from lithium ceramic materials. Dissociative hydrogen chemisorption on the Li_2O surfaces of the (100), (110), and (111) planes has been investigated with ab initio Hartree-Fock calculations. Calculations for unrelaxed crystal Li_2O structures indicated that except for the (100) surface, the (110) and (111) surfaces are stable. Results on the heterolytic sites of n-layer (110) (where $n \geq 2$) slabs and three-layer (111) slabs suggest that dissociative hydrogen chemisorption is endothermic. For a one-layer (110) slab at 100% surface coverage, the dissociative hydrogen chemisorption is exothermic, forming OH^- and $Li^+H^-Li^+$. The results also indicate that the low coordination environment in surface step structures, such as kinks and ledges, may plan an important role in the hydrogen chemisorption process. On the homolytic sites of the (110) and (111) surfaces, there is no hydrogen chemisorption.

6894 (CIEMAT–737) **Runaway transport studies in the TJ-I Tokamak.** Rodriguez, L.; Vega, J.; Rodriguez-Yunta, A; Castejon, F.; Pardo, C.; Navarro, A.P. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 27p. Order Number DE95721646. Source: OSTI; NTIS; INIS.

Runaway diffusion coefficient, Dr_r, for TJ-I tokamak has been deduced using two different methods: In the first one, D_r is obtained using the steady state approach for values of the runaway confinement time pi_r deduced from hard-X-ray Bremsstrahlung spectra; in the second method, D_r is deduced from sawteeth oscillations of HXR flux, and of SXR intensity, recorded simultaneously. Data have been taken in a scan with the toroidal magnetic field B_t.Values obtained for D_r=(5-10) m"2s"-1, decreasing with B_t are in both cases consistent. Assuming that magnetic turbulence is responsible for their transport, from D_r we can deduce b/B_t, the magnetic fluctuations level, and then infer the thermal conductivity coefficient $lambda_e$. The radial energy resolution of renaway electrons allows us to infer for b/B_T and $lambda_e$ values at the plasma edge and for an inner position about r=a/2. Results are in food agreement with those ones obtained in TJ-I using probes, spectroscopic methods, power balance analysis and a coupled analysis for temperature and density pulses.

6895 (GA-A–21741) **A vacuum window for a 1 MW CW 110 GHz gyrotron.** Moeller, C.P.; Doane, J.L.; DiMartino, M. General Atomics, San Diego, CA (United States). Jul 1994. 3p.

Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; AC03-89ER52153. (CONF-9410163–1: 19. international conference on infrared and millimeter waves, Sendai (Japan), 17-21 Oct 1994). Order Number DE94016584. Source: OSTI; NTIS; INIS; GPO Dep.

Development of high power microwave sources for fusion applications is limited by the availability of suitable vacuum windows in the 100 to 200 GHz frequency range. A novel vacuum window is described which uses water cooled sapphire as the dielectric. Heat removal is achieved by using thin slats of sapphire interleaved and brazed to niobium hexagonal tubes in which the cooling water flows. Analysis indicates a window 100 cm^2 in area can readily pass 1 MW in the HE_{11} mode at 110 GHz for current experimental applications and 1 MW with a $HE_{11}{}^0$-$HE_{12}{}^0$ mixture at 170 GHz, the projected ITER frequency.

6896 (GA-A–21789) **4 MW fast wave current drive upgrade for DIII-D.** Callis, R.W. (General Atomics, San Diego, CA (United States)); Cary, W.P.; Baity, F.W. General Atomics, San Diego, CA (United States); Oak Ridge National Lab., TN (United States); Lawrence Livermore National Lab., CA (United States). Sep 1994. 4p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; AC05-84OR21400 ; W-7405-ENG-48. (CONF-940843–12: 18. European symposium on fusion technology, Karlsruhe (Germany), 22-26 Aug 1994). Order Number DE95003741. Source: OSTI; NTIS; INIS; GPO Dep.

The DIII-D program has just completed a major addition to its ion cyclotron range of frequency (ICRF) systems. This upgrade project added two new fast wave current drive (FWCD) systems, with each system consisting of a 2 MW, 30 to 120 MHz transmitter, ceramic insulated transmission lines and tuner elements, and water-cooled four-strap antenna. With this addition of 4 MW of FWCD power to the original 2 MW, 30 to 60 MHz capability, experiments can be performed that will explore advanced tokamak plasma configurations by using the centrally localized current drive to effect current profile modifications.

6897 (GA-A–21804) **Helium-cooling in fusion power plants.** Wong, C.P.C.; Baxi, C.B.; Hamilton, C.J.; Schleicher, R.W.; Streckert, H. General Atomics, San Diego, CA (United States). Nov 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER52153. (IAEA-CN–60/F-P-2; CONF-940933–22: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003940. Source: OSTI; NTIS; INIS; GPO Dep.

This paper reviews different helium-cooled first wall and blanket designs; and compares the selection of structural materials. The authors found that the solid breeder, SiC-composite material option generates the lowest amount of induced radioactivity and afterheat and has the highest temperature capability. When combined with the direct cycle gas turbine system, it has the potential to be the most economical fusion system and can compete with advanced fission reactors. When compared to martensitic steel and V-alloy, SiC-composite is the least developed of these three structural materials, a focused development effort will be needed. Fundamental research has begun in addressing the issues of optimized composite materials, irradiation effects, leak tightness and low activation braze materials. Development of helium-cooled high heat flux components and further development of the direct cycle gas turbine system will also be needed.

6898 (GA-A–21807) **The role of shaping in achieving high performance in DIII-D.** Lazarus, E.A. (Oak Ridge National Lab., TN (United States)); Hyatt, A.W.; Osborne, T.H. General Atomics, San Diego, CA (United States); Oak Ridge National Lab., TN (United States); Lawrence Livermore National Lab., CA (United States); Sandia National Labs., Albuquerque, NM (United States); California Univ., Los Angeles, CA (United States). Dept. of Physics; California Univ., Los Angeles, CA (United States). Oct 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; AC05-84OR21400 ; W-7405-ENG-48 ; AC04-94AL85000 ; FG03-89ER51121 ; FG03-86ER53225. (IAEA-CN–60/A-5-I-1; CONF-940933–23: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003877. Source: OSTI; NTIS; INIS; GPO Dep.

Experiments to study the effect of plasma shape on performance show that the high performance levels characteristic of VH-mode plasmas are only obtained for high triangularity (δ). A characteristic difference in central heating efficiency is observed when high and low δ plasmas are compared. The authors find this difference to correlate well with the attainment of Mercier stability. The core plasma for the high δ cases achieves Mercier stability when q_0 rises above a critical value which depends on δ, providing direct access to the second-stable regime. Other attributes of the VH-mode commence after a delay. The rise in q_0 is attributable to the radial gradients in the neutral beam and bootstrap current sources. Simulation indicates that such plasmas would persist for many seconds if the rise in density could be controlled, maintaining a centrally peaked neutral beam deposition profile.

6899 (GA-A–21821) **Experimental achievement of toroidal beta beyond that predicted by "Troyon" scaling.** Taylor, T.S. (General Atomics, San Diego, CA (United States)). General Atomics, San Diego, CA (United States); Oak Ridge National Lab., TN (United States); Lawrence Livermore National Lab., CA (United States). Sep 1994. 16p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; AC05-84OR21400 ; W-7405-ENG-48. (CONF-9408176–4: ISPP workshop on the theory of fusion plasmas, Varenna (Italy), 22-26 Aug 1994). Order Number DE95003880. Source: OSTI; NTIS; INIS; GPO Dep.

Tokamak experiments have made substantial progress toward improving the experimentally achievable beta limit beyond that predicted by Troyon scaling, β_{Troyon} (%) = 2.8 I/aB MA/m/T. These advances in achievable beta have come about from the modification of the plasma profiles, primarily the current density profile, and the utilization of stabilizing conducting structures. Both theory and experiment have shown that the beta limit increases with peaked current density profiles, high ℓ_i, and broad pressure profiles; scaling of the beta limit β_{max} (%) = 4 ℓ_i I/aB has been proposed. Experiments in DIII-D, TFTR, and JT-60U have all confirmed the increase of β with ℓ_i, using high powered heating and negative current ramps to increase ℓ_i. It is recognized that high ℓi_i is difficult to maintain at high β_N in steady-state conditions as a consequence of the profile of the bootstrap current: β is limited by low n external kinks. Profiles with a negative central shear and high edge current density have been proposed that are stable to the low n external kinks provided there is a stabilizing influence from a resistive wall. Experiments from PBX-M and DIII-D provide evidence that wall stabilization is effective and recent experiments at DIII-D have resulted in β_T = 12.5% and β_N = 4.3 at ℓ_i = 0.72 and q_{95} = 2.5; conditions that are expected to have a lower beta limit in the absence of wall stabilization.

6900 (GA-A–21840) **DIII-D program overview.** Stambaugh, R.D. General Atomics, San Diego, CA (United States); Lawrence Livermore National Lab., CA (United States); Oak Ridge National Lab., TN (United States); California Univ., Los Angeles, CA (United States); Sandia National Labs., Albuquerque, NM (United States). Oct 1994. 20p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; W-7405-ENG-48 ; AC05-84OR21400 ; FG03-86ER53225 ; AC04-94AL85000. (CONF-940933–19: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003879. Source: OSTI; NTIS; INIS; GPO Dep.

Recent DIII-D results support the feasibility of advanced tokamak operation ($H \equiv \tau_E/ITER89P$ up to 4 and $\beta_N \equiv \beta_T/(IaB_T)$ up to 6). Plasma rotation dynamics have been shown to be the key to the confinement improvement in H- and VH-mode, leading to the highest DIII-D fusion triple product of $n_D(0)\ \tau_E\ T_i(0) = 5 \times 10^{20}$ keV s/m^3. Plasma rotation, wall stabilization, and current profile control are important in exceeding nominal stability performance β_N = 3.5 and have assisted in achieving β_T = 12.5%. Excellent exhaust of deuterium and helium in ELMing H-mode was achieved in divertor operation using an in-vessel cryopump. Reduction of divertor heat loads was shown by radiative divertor operation. Achieving impurity

entrainment adequate for radiative divertor operation remains an objective of a future Radiative Divertor installation.

6901 (GA-A–21851) **Divertor research on the DIII-D tokamak.** Hill, D.N. (Lawrence Livermore National Lab., CA (United States)); Allen, S.L.; Brooks, N.H. General Atomics, San Diego, CA (United States); Oak Ridge National Lab., TN (United States); Sandia National Labs., Albuquerque, NM (United States); California Univ., Los Angeles, CA (United States). Dept. of Physics; California Univ., Los Angeles, CA (United States); Lawrence Livermore National Lab., CA (United States). Oct 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-89ER51114 ; AC05-84OR21400 ; AC04-94AL85000 ; FG03-89ER51121 ; FG03-86ER53225 ; W-7405-ENG-48. (IAEA-CN–60/A-4-I-2; CONF-940933–21: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003942. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper the authors summarize recent progress on DIII-D in developing techniques for divertor power and particle control relevant to next generation tokamaks such as the proposed ITER and TPX devices. Density control and helium removal by divertor pumping have been demonstrated for the first time in high confinement ELMing H-mode discharges ($\tau \sim 2 \times \tau_{ITER-89P}$) following installation of a divertor cryopumping system. The peak divertor heat flux in similar H-mode discharges has been reduced through production of a radiating mantle with neon or argon puffing (reductions of 3–5). A number of diagnostics have been added to improve the understanding of the physical processes involved. They are now designing modified double-null divertor structures for DIII-D that will provide improved particle control for high-triangularity VH-mode plasmas while at the same time allowing for gas puffing to reduce the divertor heat flux.

6902 (JAERI-Tech–94-002) **Critical element development of standard pipe connector for remote handling.** Taguchi, Kou (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kakudate, Satoshi; Kanamori, Naokazu; Oka, Kiyoshi; Nakahira, Masataka; Obara, Kenjiro; Tada, Eisuke; Shibanuma, Kiyoshi; Seki, Masahiro. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 26p. Order Number DE95737226. Source: OSTI; NTIS; INIS.

In fusion experimental reactors such as ITER, the in-vessel components such as blanket and divertor are actively cooled and a large number of cooling pipes are located around the core of reactor, where personnel access is prohibited. Mechanical pipe connectors are highly required as standard components for easy and reliable connection/disconnection of cooling pipe by remote handling. For this purpose, a clamping chain type connector has been developed with special mechanisms such as plate springs and guide structures so as to enable concentric and axial movement of clamping chain for easy mounting and dismounting. The basic performance test of a prototypical connector for a 80-A pipe shows sufficient leak tightness and proof pressure capability as well as simple connection/disconnection operation. In addition to the clamp chain type connector, design efforts have been made to develop a quick coupling type connector and a preliminary model of air-actuated quick connector has been fabricated for further investigations. This paper gives the design concept of mechanical pipe connectors such as clamping chain type and quick coupler type, and the basic performance tests results of clamping chain type connector. (author).

6903 (JAERI-Tech–94-003) **Irradiation tests of critical components for remote handling in gamma radiation environment.** Obara, Henjiro (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kakudate, Satoshi; Oka, Kiyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 81p. Order Number DE95737223. Source: OSTI; NTIS; INIS.

Since the fusion power core of a D-T fusion reactor will be highly activated once it starts operation, personnel access will be prohibited so that assembly and maintenance of the components in the reactor core will have to be totally conducted by remote handling technology. Fusion experimental reactors such as ITER require unprecedented remote handling equipments which are tolerable under gamma radiation of more than 10^6 R/h. For this purpose, the Japan Atomic Energy Research Institute (JAERI) has been developing radiation hard components for remote handling purpose and a number of key components have been tested over 10^9 rad at a radiation dose rate of around 10^6 R/h, using Gamma Ray Radiation Test Facility in JAERI-Takasaki Establishment. This report summarizes the irradiation test results and the latest status of AC servo motor, potentiometer, optical elements, lubricant, sensors and cables, which are key elements of the remote handling system. (author).

6904 (JAERI-Tech–94-006) **Development of integrated insulation joint for cooling pipe in tokamak reactor.** Nishio, Satoshi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Abe, Tetsuya; Kawamura, Masashi; Yamazaki, Seiichiro. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 23p. Order Number DE95737220. Source: OSTI; NTIS; INIS.

In a tokamak fusion reactor, an electrically insulated part is needed for an in-vessel piping system in order to break an electric circuit loop. When a closed loop is formed in the piping system, large induced electromagnetic forces during a plasma disruption (rapid plasma current quench) could give damages on the piping system. Ceramic brazing joint is a conventional method for the electric circuit break, but an application to the fusion reactor is not feasible due to its brittleness. Here, a stainless steel/ceramics/stainless steel functionally gradient material (FGM) has been proposed and developed as an integrated insulation joint of the piping system. Both sides of the joint can be welded to the main pipes, and expected to be reliable even in the fusion reactor environment. When the FGM joint is manufactured by way of a sintering process, a residual thermal stress is the key issue. Through detailed computations of the residual thermal stress and several trial productions, tubular elements of FGM joints have been successfully manufactured. (author).

6905 (JAERI-Tech–94-007) **Design study of prototype accelerator and MeV test facility for demonstration of 1 MeV, 1 A negative ion beam production.** Inoue, Takashi (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Hanada, Masaya; Miyamoto, Kenji; Ohara, Yoshihiro; Okumura, Yoshikazu; Watanabe, Kazuhiro; Maeno, Shuichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 95p. Order Number DE95737208. Source: OSTI; NTIS; INIS.

In fusion reactors such as ITER, a neutral beam injector of MeV class beam energy and several tens MW class power is required as one of candidates of heating and current drive systems. However, the beam energy of existing high power accelerators are one order of magnitude lower than the required value. In order to realize a neutral beam injector for the fusion reactor, 'Proof-of-Principle' of such high energy acceleration is a critical issue at a reactor relevant beam current and pulse length. An accelerator and an accelerator facility which are necessary to demonstrate the Proof-of-Principle acceleration of negative ion beams up to 1 MeV, have been designed in the present study. The accelerator is composed of a cesium-volume type ion source and a multi-stage electrostatic acceleration system [Prototype Accelerator]. A negative hydrogen ion beam with the current of about one ampere (1 A) can be accelerated up to 1 MeV at a low operating pressure. Two types of acceleration system, a multi-multi type and a multi-single type, have been studied. The test facility has sufficient capability for the test of the Prototype Accelerator [MeV Test Facility]. The dc high voltage generator for negative ion acceleration is a Cockcroft-Walton type and capable of delivering 1 A at 1 MV (=1 MW) for 60 s. High voltage components including Prototype Accelerator are installed in a SF_6 vessel pressurized at 6 kg/cm^2 to overcome high voltage gradients. The vessel and the beamline are installed in a X-ray shield. (author).

6906 (JAERI-Tech–94-009) **Development and trial manufacturing of 1/2-scale partial mock-up of blanket box structure for fusion experimental reactor.** Hashimoto, Toshiyuki (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Takatsu, Hideyuki; Sato, Satoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1994. 78p. (In Japanese). Order Number DE95737184. Source: OSTI; NTIS; INIS.

Conceptual design of breeding blanket has been discussed during the CDA (Conceptual Design Activities) of ITER (International Thermonuclear Experimental Reactor). Structural concept of breeding blanket is based on box structure integrated with first wall and shield, which consists of three coolant manifolds for first wall, breeding and shield regions. The first wall must have cooling channels to remove surface heat flux and nuclear heating. The box structure includes plates to form the manifolds and stiffening ribs to withstand enormous electromagnetic load, coolant pressure and blanket internal (purge gas) pressure. A 1/2-scale partial model of the blanket box structure for the outboard side module near midplane is manufactured to estimate the fabrication technology, i.e. diffusion bonding by HIP (Hot Isostatic Pressing) and EBW (Electron Beam Welding) procedure. Fabrication accuracy is a key issue to manufacture first wall panel because bending deformation during HIP may not be small for a large size structure. Data on bending deformation during HIP was obtained by preliminary manufacturing of HIP elements. For the shield structure, it is necessary to reduce the welding strain and residual stress of the weldment to establish the fabrication procedure. Optimal shape of the parts forming the manifolds, welding locations and welding sequence have been investigated. In addition, preliminary EBW tests have been performed in order to select the EBW conditions, and fundamental data on built-up shield have been obtained. Especially, welding deformation by joining the first wall panel to the shield has been measured, and total deformation to build-up shield by EBW has been found to be smaller than 2 mm. Consequently, the feasibility of fabrication technologies has been successfully demonstrated for a 1m-scaled box structure including the first wall with cooling channels by means of HIP, EBW and TIG (Tungsten Inert Gas arc)-welding. (author).

6907 (JAERI-Tech–94-011) **Design concept of a cryogenic distillation column cascade for a ITER scale fusion reactor.** Yamanishi, Toshihiko (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Enoeda, Mikio; Okuno, Kenji. Japan Atomic Energy Research Inst., Tokyo (Japan). Jul 1994. 37p. Order Number DE95737185. Source: OSTI; NTIS; INIS.

A column cascade has been proposed for the fuel cycle of a ITER scale fusion reactor. The proposed cascade consists of three columns and has significant features: either top or bottom product is prior to the other for each column: it is avoided to withdraw side streams as products or feeds of down stream columns: and there is no recycle steam between the columns. In addition, the product purity of the cascade can be maintained against the changes of flow rates and compositions of feed streams just by adjusting the top and bottom flow rates. The control system has been designed for each column in the cascade. A key component in the prior product stream was selected, and the analysis method of this key component was proposed. The designed control system never brings instability as long as the concentration of the key component is measured with negligible time lag. The time lag for the measurement considerably affects the stability of the control system. A significant conclusion by the simulation in this work is that permissible time for the measurement is about 0.5 hour to obtain stable control. Hence, the analysis system using the gas chromatography is valid for control of the columns. (author).

6908 (JAERI-Tech–94-012) **Critical element development of double seal door for tritium containment.** Kanamori, Naokazu (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Kakudate, Satoshi; Oka, Kiyoshi; Nakahira, Masataka; Taguchi, Kou; Obara, Kenjiro; Tada, Eisuke; Shibanuma, Kiyoshi; Seki, Masahiro. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 25p. Order Number DE95737221. Source: OSTI; NTIS; INIS.

In fusion experimental reactors, the in-vessel components such as blanket are activated due to D-T operation and they have to be assembled and replaced by remote operation through port penetration of plasma vacuum vessel. A double seal door is inevitably required at an interface between vacuum vessel port and maintenance cask in order to avoid the dispersion of tritium and activated dust during in-vessel component handling. The double seal door should have two open/close doors with four seal surfaces so as to keep leak tightness both of the vacuum vessel and the maintenance cask when doors closed, and to provide access space for handling in-vessel components when doors opened. A prototype compact double seal door with an attractive kinematics of parabolic trajectory has been proposed so as to minimize dead space for the door open/close operation, compared with ordinary slide or hinge type door. Based on this design concept, a sub-scaled model of double seal door with trapezoidal cross-section of around 0.2 m^2 has been fabricated. Through the preliminary experiments such as open/close performance, the double seal door mechanism with parabolic trajectory has been successfully demonstrated. As for leak tightness, seal characteristics of a polyimide ring irradiated up to 10 MGy have been measured. (author).

6909 (JAERI-Tech–94-013) **Hydrogen formation in metals and alloys during fusion reactor operation.** Zimin, S. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Takatsu, Hideyuki; Mori, Seiji. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 25p. Order Number DE95737224. Source: OSTI; NTIS; INIS.

The results of neutron transport calculations of the hydrogen formation based on the JENDL gas-production cross section file are discussed for some metals and alloys, namely ^{51}V, Cr, Fe, Ni, Mo, austenitic stainless steel (Ti modified 316SS:PCA), ferritic steel (Fe-8Cr-2W:F82H) and the vanadium-base alloy (V-5Cr-5Ti). Impact of the steel fraction in steel/water homogeneous blanket/shield compositions on the hydrogen formation rate in above-mentioned metals and alloys is discussed both for the hydrogen formation in the first wall and the blanket/shield components. The results obtained for the first wall are compared with those for the helium formation obtained at JAERI by the same calculational conditions. Hydrogen formation rates at the first wall having ^{51}V, Cr, Fe, Ni and Mo are larger than those of helium by 3-8 times. (author).

6910 (JAERI-Tech–94-015) **Shielding analysis of the ITER/EDA NBI duct.** Zimin, S. (Japan Atomic Energy Research Inst., Naka, Ibaraki (Japan). Naka Fusion Research Establishment); Takatsu, Hideyuki; Sato, Satoshi; Tsunematsu, Toshihide; Inoue, Takashi; Ohara, Yoshihiro; Maki, Koichi. Japan Atomic Energy Research Inst., Tokyo (Japan). Aug 1994. 42p. Order Number DE95737222. Source: OSTI; NTIS; INIS.

This report discusses the shielding properties of the ITER/EDA NBI ducts based on the current JCT design of the 24 superconductive toroidal field coils (the 24 TFC). The two-dimensional transport calculations have been performed by DOT 3.5. First, the neutron fluxes, dose to insulator and peak nuclear heating rate were calculated in the TFC and the NBI duct. The X-Y calculational model with detail description of the neutron source shape and the TFC geometry is used for that calculation. Second, the R-Z calculational model with detail description of the NBI components was set up. The nuclear heating in the NBI cryo panels and displacement damage in NBI copper grids were obtained in that calculation. In summary, it it concluded that the shielding performance of the current NBI duct design is enough to decrease all considered neutronics responses below the limits. (author).

6911 (KFK–5271) **Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.** Dalle Donne, M. (ed.). Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. 349p. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

As shown by recent developments beryllium has become one of the most important materials in the development of fusion reactors. It is practically the only neutron multiplier available for blankets with ceramic breeder materials and can be used with liquid metal breeders as well. It is one of the most likely materials to be used on the surface of the first walls and of the divertor. The neutron irradiation behavior of beryllium in a fusion reactor is not well know. Beryllium was extensively irradiated about 25-40 years ago and has been used since then in material testing reactors as reflector.

In the meantime, however, beryllium has been improved quite considerably. Today it is possible to obtain commercially beryllium which is much more isotropic and contains smaller ammounts of oxide. There are already indications that these new kinds of beryllium behave better under irradiation. (orig.)

6912 (KFK–5271, pp. 4-35) **Optimization of beryllium for fusion blanket applications.** Billone, M.C. (Fusion Power Program, Argonne National Lab., IL (United States)). Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The primary function of beryllium in a fusion reactor blanket is neutron multiplication to enhance tritium breeding. However, because heat, tritium and helium will be generated in and/or transported through beryllium and because the beryllium is in contact with other blanket materials, the thermal, mechanical, tritium/helium and compatibility properties of beryllium are important in blanket design. In particular, tritium retention during normal operation and release during overheating events are safety concerns. Accommodating beryllium thermal expansion and helium-induced swelling are important issues in ensuring adequate lifetime of the structural components adjacent to the beryllium. Likewise, chemical/metallurgical interactions between beryllium and structural components need to be considered in lifetime analysis. Under accident conditions the chemical interaction between beryllium and coolant and breeding materials may also become important. The performance of beryllium in fusion blanket applications depends on fabrication variables (e.g., grain size, porosity, and impurity content) and operational parameters (heat generation rate and temperature profile, tritium generation rate profile, helium generation rate profile, displacement damage rate profile, external stresses, etc.). First the properties database is reviewed to determine our state of knowledge of beryllium performance as a function of these variables. Several design calculations are then performed to indicate ranges of fabrication and operation variables that lead to optimum beryllium performance. Finally, areas for database expansion and improvement are highlighted based on the properties survey and the design sensitivity studies. (orig.)

6913 (KFK–5271, pp. 36-61) **Radiation effects in beryllium used for plasma protection.** Gelles, D.S. (Pacific Northwest Lab., Richland, WA (United States)); Dalle Donne, M.; Sernyaev, G.A.; Kawamura, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

This paper reviews the literature on beryllium, emphasizing the effects of irradiation on essential properties. Swelling and embrittlement experiments as a function of irradiation temperature and dose, and and as a function of neutron spectrum are described, and the results are quantified, where possible. Effects of impurity content are also reported, from which optimum composition specifications can be defined. Microstructural information has also been obtained to elucidate the processes controlling the property changes. The available information indicates that beryllium divertors can be expected to embrittle quickly and may need frequent replacement. (orig.)

6914 (KFK–5271, pp. 62-87) **Defect formation in single crystalline beryllium.** Muecklich, F. (Max-Planck-Inst. fuer Metallforschung, Stuttgart, PML (Germany)); Scholz, U.; Petzow, G. Kernforschungszentrum Karlsrune GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The paper presents some studies on the mechanisms of dislocation formation in single crystalline Beryllium. Due to the low solubilities of only ppm for most of the impurity atoms in the Beryllium lattice, precipitation formation limits the single crystal growth very strictly. Therefore measurements with high sensitivity such as Rutherford Backscattering have been applied to find reliable estimations for absolute solubilities of the most critical impurities and for their local distribution with respect to defect arrangements such as subgrain boundaries. The strong mechanical anisotropy of the hexagonal Beryllium lattice is a key factor controlling the dislocation formation procedures during crystal growth and also during crystal annealing as well as during deformation procedures. (orig.)

6915 (KFK–5271, pp. 88-104) **Helium content and swelling of low temperature irradiated /post-irradiation annealed beryllium.** Sannen, L. (S.C.K./C.E.N., Mol (Belgium)); Moons, F.; Yao, Y. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Beryllium specimens produced by vacuum hot pressing have been irradiated since 1980 in the material testing reactor BR2, up to a fast fluence of 4 x 10^{22} n/cm^2 (E > 1 MeV) at 40-50 C. The helium production and induced swelling of beryllium have been determined as a function of neutron fluence. The enhancement of the swelling as due to post-irradiation annealing up to 800 C for 24 h has also been evaluated and correlated with the neutron fluence and annealing temperature. The main experimental results are as follows : 1. Both irradiation swelling and helium content show a linear dependence on fast neutron fluence (E > 1 MeV) : the swelling rate amounts to 0.581 % per 10^{22} n/cm^2 fluence, and the helium production rate is 4880 appm/10^{22} n/cm^2. 2. The swelling after post-irradiation annealing can be correlated with the neutron fluence to the second power and with the annealing temperature to the fourth power. 3. The helium content measurements on the post-irradiation annealed specimens show that no helium is released during the annealing time considered (24 h max.) except at high temperature (800 C). (orig.)

6916 (KFK–5271, pp. 105-119) **Modelling He-induced swelling in beryllium during fast neutron irradiation.** Dalle Donne, M. (Kernforschungszentrum Karlsruhe, Inst. fuer Neutronenphysik und Reaktortechnik (Germany)); Scaffidi-Argentina, F.; Ferrero, C.; Ronchi, C. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The most important effects of neutron irradiation on beryllium are swelling, embrittlement and tritium retention. The helium produced by the ^{9}Be(n,2n)2 ^{4}He reaction is the cause of beryllium swelling which is the main limiting lifetime factor for the material. It was, therefore, decided to develop a computer code capable of describing the helium behaviour in beryllium; the approach used was to

modify an existing code available for the modelling of the UO_2 performance in fission reactors. The resulting code ANFIBE (ANalysis of Fusion Irradiated BEryllium) allows the calculation of gas distribution, induced swelling and helium release from beryllium. Good agreement between experimental and calculated swelling has been found. (orig.)

6917 (KFK–5271, pp. 120-137) **Tritium release studies of irradiated beryllium.** Baldwin, D.L. (Battelle, Pacific Northwest Lab., Richland, WA (United States)). Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

This presentation is a summary of Be studies, conducted at the Pacific Northwest Laboratory, relating stepped isothermal anneal tritium release measurements with thermal-ramp temperature programmed desorption measurements. Three ATR-irradiated Be specimens, covering the density range of 81% to 100% TD, have been tested by a stepped-thermal anneal technique. Data analysis of the tritium release curves using a diffusion/desorption model has yielded effective tritium diffusion coefficients, desorption-rate constants and the corresponding activation energies. The results from this model show diffusion to be the predominant rate-limiting mechanism under isothermal conditions with small and varying contribution by surface desorption. The 100% TD Be has also been tested by a thermal-ramp temperature-programmed desorption technique. Results from the stepped-thermal anneal and temperature-programmed desorption technique is summarized and compared. (orig.)

6918 (KFK–5271, pp. 138-148) **Long-time tritium release from irradiated beryllium (SIBELIUS irradiation).** Doerr, L. (Kernforschungszentrum Karlsruhe GmbH (Germany). Hauptabteilung Versuchstechnik); Eberle, T.; Lebkuecher, J.; Werle, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Tritium is produced in beryllium, which is used as neutron-multiplier in ceramic fusion blankets, by fast neutrons. Although the production rate is about two to three orders of magnitude smaller than that of the breeder ceramic, initial tritium release tests with beryllium samples from the SIBELIUS irradiation indicated that, because of the very slow release at typical blanket temperatures (400 - 700 C), the inventory might become large during the DEMO blanket lifetime ($\simeq$ 3 y). An extrapolation of the short-time (several days) tritium release tests to longer times is difficult because the inventory decrease with time is not exponential. Therefore a long-time annealing test with beryllium samples from the SIBELIUS irradiation has been started February 1993. Samples are purged and annealed up to 12 months at 380, 450, 550 and 650 C. Residual inventories after annealing are determined by purging and heating to 850 C. Results for not-annealed and 3-, respectively 6-month annealed samples are presented. (orig.)

6919 (KFK–5271, pp. 149-163) **Computer simulation of tritium retention and release in irradiated beryllium.** Dalle Donne, M. (Kernforschungszentrum Karlsruhe, Inst. fuer Neutronenphysik und Reaktortechnik (Germany)); Scaffidi-Argentina, F.; Ferrero, C.; Ronchi, C. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The helium produced by the $^{9}Be(n,2n)2\,^{4}He$ and the oxygen impurities present in the material appear to be the main cause of tritium retention in irradiated beryllium. Because of the strong relation between the helium bubbles distribution and tritium release, it was decided to extend the code ANFIBE (ANalysis of Fusion Irradiated BEryllium), initially used to describe the helium induced swelling in beryllium, by including a new model describing the trapping effects on tritium due to chemical reactions with beryllium oxyde and capture in helium bubbles. The resulting modified code allows the calculation of tritium distribution and release from beryllium. Good agreement between calculated and experimental data was found. (orig.)

6920 (KFK–5271, pp. 164-171) **Research of beryllium safety issues.** Longhurst, G.R. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Anderl, R.A.; Dolan, T.J.; Hankins, M.R.; Pawelko, R.J. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Beryllium has been identified as a leading contender for the plasma-facing material in ITER. Its use has some obvious advantages, but there are also a number of safety concerns associated with it. The Idaho National Engineering Laboratory (INEL) has undertaken a number of studies to help resolve some of these issues. One issue is the response of beryllium to neutron irradiation. We have tested samples irradiated in the Advanced Test Reactor (ATR) and are currently preparing to make measurements of the change in mechanical properties of beryllium samples irradiated at elevated temperatures in the Fast Flux Test Facility (FFTF) and the Experimental Breeder Reactor II (EBR-II) at the INEL. Mechanical tests will be conducted at the irradiation temperatures of 375-550 C. Other experiments address permeation and retention of implanted tritium in plasma-sprayed beryllium. In one test the porosity of the material allowed 0.12% of implanted ions and 0.17% of atoms from background gas pressure to pass through the foil with essentially no delay. For comparison, similar tests on fully dense hot-rolled, vacuum melted or sintered powder foils of high purity beryllium showed only 0.001% of implanting ions to pass through the foil, and then only after a delay of several hours. None of the molecular gas appeared to permeate these latter targets. An implication is that plasma-sprayed beryllium may substantially enhance recycling of tritium to the plasma provided it is affixed to a relatively impermeable substrate. (orig.)

6921 (KFK–5271, pp. 172-184) **Measurements of the heat transfer parameters of mixed beds of beryllium and lithium orthosilicate pebbles.** Dalle Donne, M. (Kernforschungszentrum Karlsruhe, Inst. fuer Neutronenphysik und Reaktortechnik (Germany)); Goraieb, A.; Sordon, G. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The Karlsruhe solid breeder blanket design for the DEMO is based on the use of a mixed bed of 2 mm beyllium and 0.1 - 0.2 mm Li_4SiO_4 pebbles with and without 0.08 - 0.18 mm beryllium pebbles. This arrangement allows to withstand better the neutron

irradiation effects on beyllium (swelling, embrittlement). The proposed mixed beds should have high heat transfer parameters (thermal conductivity, wall heat transfer coefficient) due to the high packing factor (≈ 80 %) and to the fact that the contact between the high conducting metallic pebbles is maintained. This is important, because the maximum pebble bed temperature in the blanket should be less than 700 C. The bed heat transfer parameters have been measured in an annular test section having on the axis an electrically heated rod. Three beds have been investigated: a bed of 2 mm beryllium pebbles, a mixed bed with 2 mm beryllium pebbles and 0.1 - 0.2 mm Li_4SiO_4 pebbles and a mixed bed with 2 mm beryllium pebbles and a mixture of 50 % 0.1 - 0.2 mm Li_4SiO_4 and 50 % 0.08 - 0.18 mm beryllium pebbles. The measurements have confirmed that the heat transfer parameters of the mixed beds, especially those of the bed with the small beryllium pebbles, are considerably higher than those of the bed with the 2 mm beryllium pebbles. (orig.)

6922 (KFK–5271, pp. 185-199) **Beryllium research activity in JAERI.** Kawamura, Hiroshi (Japan Atomic Energy Research Inst., Oarai Research Establishment, Ibaraki (Japan)); Ishitsuka, Etsuo. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The present status of Beryllium study in JAERI will be presented in this work. Some new programs are attempting in JAERI; compression test, vacuum heating, so on. The low impurity and low cost pebble production were developed by using improved rotating electrode method. The thermal expansion coefficient and specific heat of the unirradiated pebble samples were measured by the laser interferometer and differential scanning calorimetry (DSC), respectively. These thermal properties were almost corresponded with the balk beryllium. The compression test was conducted for the evaluation of mechanical property. The irradiated pebbles of total first neutron fluence of 1.3×10^{25}(n/m^2) were tested at the room temperature. The embrittlement of irradiated beryllium pebbles was found from these results. (orig.)

6923 (KFK–5271, pp. 200-218) **Compatibility between beryllium and stainless steel.** Kato, M. (NGK Insulator Co., Ltd., Aichi (Japan)); Kawamura, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Beryllium has been used for the neutron multiplier in fusion blanket, and inserted into the structural material. And, 316 Stainless Steel has been proposed as the structural material. However, the elementary process of reaction between beryllium and 316SS did not clear in detail. Therefore, we conducted the diffusion couple test in order to make clear the elementary process of reaction between beryllium and 316SS. The combinations of the diffusion couple were three kinds, i.e., Be/316SS, Be/Fe.Cr alloy and Be/Ni. Each diffusion couples was sealed in capsule with high purity Helium(6N) by TIG welding, and was annealed for 100, 300 and 1000h per at each temperature, i.e. 400, 600 and 800 C. (orig.)

6924 (KFK–5271, pp. 219-232) **Compatibility between beryllium and ceramic coating film.** Kawamura, H. (Japan Atomic Energy Research Inst., Oarai Research Establishment, Ibaraki (Japan)); Kato, M.; Miyajima, K. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Beryllium is indispensable for fusion blanket as the neutron multiplier and inserted into the structural material(316SS) on Japanese blanket concept. In this case, chemical interaction between beryllium and 316SS has been observed above 600 C, and BeNi was formed on 316SS side at this temperature. Therefore, we are considering a chromic oxide coating on 316SS surface as the diffusion barrier of beryllium into 316SS, because the reaction between beryllium and chromium was not observed and the component of this coating film did not contain nickel. From the results, it made clear that ceramic coating film(50 μ m) had a function as reaction barrier completely against 316SS at 800 C -300h annealing similar to 600 C -1000h annealing. (orig.)

6925 (KFK–5271, pp. 233-251) **Properties of beryllium as a plasma facing material.** Eckstein, W. (Max-Planck-Inst. fuer Plasmaphysik, Garching (Germany)); Behrisch, R.; Scherzer, B.M.U.; Roth, J. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Beryllium is investigated with respect to criteria important for plasma facing materials such as erosion, hydrogen trapping and heat removal. Beryllium tiles from JET are analyzed with SEM and the ion beam techniques of NRA, PIXE, RBS and HIERD. This paper concentrates on work performed at MPIPP. (orig.)

6926 (KFK–5271, pp. 252-276) **The effect of processing parameters on plasma sprayed beryllium for fusion applications.** Castro, R.G. (Material Science and Technology Div., Los Alamos National Lab., NM (United States)); Stanek, P.W.; Jacobson, L.W.; Cowgill, D.F. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Plasma spraying is being investigated as a potential coating technique for applying thin (0.1-5mm) layers of beryllium on plasma facing surfaces of blanket modules in ITER and also as an in-situ repair technique for repairing eroded beryllium surfaces in high heat flux divertor regions. High density spray deposits (>98% of theoretical density) of beryllium will be required in order to maximize the thermal conductivity of the beryllium coatings. A preliminary investigation was done to determine the effect of various processing parameters (particle size, particle morphology, secondary gas additions and reduced chamber pressure) on the as-deposited density of beryllium. The deposits were made using spherical beryllium feedstock powder which was produced by centrifugal atomization at Los Alamos National Laboratory (LANL). Improvements in the as-deposited densities and deposit efficiencies of the beryllium spray deposits will be discussed along with the corresponding thermal conductivity and outgassing behavior of these deposits. (orig.)

6927 (KFK–5271, pp. 277-283) **Beryllium high heat-flux tests at JET.** Deksnis, E.B. (Commission of the European Communities, Abingdon (United Kingdom). JET Joint Undertaking); Altmann, H.; Falter, H.; Ibbott, C. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe

GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

JET has operated with large areas of beryllium exposed to plasma in both the limiter and divertor configuration. Tests to beryllium tiles proposed for the inertial Pumped Divertor of JET suggest that castellations of 6 x 6 mm are required to sustain heat fluxes of up to 15 MW/m^2 for 5 x 10^3 pulses and no appreciable fatigue failure of the irradiated surface. However, at 27 MW/m^2 fatigue cracks appeared lateral to the irradiated surface and these cracks cause the surface to melt without fatigue failure of the hot areas. There may be a strong dependence of fatigue life of beryllium on the initial temperature of the component. (orig.)

6928 (KFK–5271, pp. 284-306) **Solid state bonding of beryllium to copper and vanadium.** Floyd, D.R. (Mfg. Sciences Corp., Oak Ridge, TN (United States)); Liby, A.L.; Weaver, W. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

The intent of this effort was to demonstrate that ingot metallurgy (IM) beryllium (Be) can be bonded to dissimilar metals such as copper (Cu) or vanadium (V) at low temperatures by using silver (Ag) as a bonding aid. It is hoped that success at the coupon stage will stimulate more extensive studies of the mechanical and thermal integrity of such joints, leading ultimately to use of this technology to fabricate first wall structures for ITER. (orig.)

6929 (KFK–5271, pp. 307-318) **The feasibility of beryllium as structural material for the ITER plasma-facing components (PFC).** Vieider, G.; Cardella, A.; Gorenflo, H. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Be as plasma-facing armour has attractive features including excellent plasma compatibility, no T-retention via co-deposition and the potential for in-situ repair via plasma spraying. In order to avoid the bonding of the Be-armour to a heatsink structure in e.g., Cu-alloys, the ITER Joint Central Team (JCT) proposed for the divertor tubular elements with monolithic Be, both as plasma-facing and structural material. The analysis of these Be-tubes with 5 mm wall thickness at a heat load of 5 MW/m^2 showed that even for the most favourable assumptions thermal stresses exceed by far the allowed values according to design codes. Damage by neutrons and disruptions would worsen further the case for Be as monolithic plasma-facing and structural material. For PFC at heat flux significantly above 1 MW/m^2 it appears evident that Be should be used merely as armour bonded to a suitable structural material as heatsink. (orig.)

6930 (KFK–5271, pp. 319-330) **Laser desorption and depth profiling study of hydrogen and deuterium implanted in beryllium.** Keroack, D. (INRS-Energie et Materiaux, Univ. du Quebec, Varennes, PQ (Canada)); Schiettekatte, F.; Terreault, B.; Ross, G.G. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Pulsed laser desorption was used to investigate the reemission of deuterium implanted in beryllium. The amount of H_2 or D_2 molecules released and the evolution of the H and D depth profiles as a function of the laser energy density was measured on samples with different implantation energies and doses. Numerical modelling of our results indicates that detrapping and diffusion are the limiting processes. At low fluence the data are best fitted with second order detrapping with a trap energy of 1.7 $\pm$ 0.1 eV and the effective diffusion coefficient is described by the equation $D = (8 \pm 1) \times 10^{-4} \exp(-0.32 \pm .02\ eV/kT)\ cm^2/s$. At high fluence the detrapping energy is $\leq$1 eV/molecule and extremely rapid migration has to be considered. The transition between these two regimes corresponds approximately to the fluence for which blistering becomes detectable. (orig.)

6931 (KFK–5271, pp. 331-341) **Thermal desorption of implanted helium from beryllium.** Zakaria, Y.M. (Dept. of Engineering Physics, McMaster Univ., Hamilton, ON (Canada)); Macaulay-Newcombe, R.G.; Thompson, D.A. Kernforschungszentrum Karlsruhe GmbH (Germany). Inst. fuer Neutronenphysik und Reaktortechnik; Kernforschungszentrum Karlsruhe GmbH (Germany). Projekt Kernfusion; Association Euratom-Kernforschungszentrum Karlsruhe GmbH (KFK) (Germany). Dec 1993. (CONF-9310182–: Workshop on beryllium for fusion applications, Karlsruhe (Germany), 4-5 Oct 1993). In *Workshop on beryllium for fusion applications. Proceedings. IEA Implementing Agreement for a Programme of Research and Development on Fusion Materials.* 349p. Order Number DE95726893. Source: OSTI; NTIS (US Sales Only); INIS.

Hot isostatic pressed foils of 99.5 wt.% beryllium have been implanted at room temperature with 30 keV helium to fluences ranging from 10^{20} to 10^{21} He$^+$/m^2. Linear ramp thermal desorption measurements up to 1073 K ($\approx$ 0.7 T_m) were performed to study the mechanisms by which the helium is trapped. Some of the samples have been deliberately corroded to investigate the effect of the surface contamination on the helium release. (orig.)

6932 (LA-UR–94-3945) **Hydrodynamic instabilities in inertial confinement fusion.** Hoffman, N.M. Los Alamos National Lab., NM (United States). [1994]. 36p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-9408127–5: 45. Scottish Universities summer school in physics, Fife (United Kingdom), 7-20 Aug 1994). Order Number DE95003663. Source: OSTI; NTIS; INIS; GPO Dep.

The focus of the paper is on buoyancy-driven instabilities of the Rayleigh-Taylor type, which are commonly regarded as the most important kind of hydrodynamic instability in inertial-confinement-fusion implosions. The paper is intended to be pedagogical rather than research-oriented, and so is by no means a comprehensive review of work in this field. Rather, it is hoped that the student will find here a foundation on which to build an understanding of current research, and the experienced researcher will find a compilation of useful results. The aim of the paper is to discuss the evolution of a single Rayleigh-Taylor-unstable mode, from its linear phase to its late-stage constant-velocity bubble growth, with a brief consideration of the saturation of linear growth. The influence of other modes in invoked only in the short-range sense (in wavenumber space) of the Haan saturation model. Owing to limitations of space, the treatment of other instabilities such as Richtmyer-Meshkov and Kelvin-Helmholtz is necessarily very brief, and entirely inadequate as an introductory discussion. Likewise, there is no reference to the effect of convergent geometry, to long-range mode coupling, or to shape effects in three-dimensional growth. Furthermore, there is no reference to the large body of experimental research related to hydrodynamic instabilities.

6933 (LBL–35960) **High current induction linacs.** Barletta, W.; Faltens, A.; Henestroza, E.; Lee, E. Lawrence Berkeley Lab., CA (United States). Jul 1994. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (HIFAN–666; CONF-9407103–32: International conference on

accelerator-driven transmutation technologies and applications, Las Vegas, NV (United States), 25-28 Jul 1994). Order Number DE95003442. Source: OSTI; NTIS; INIS; GPO Dep.

Induction linacs are among the most powerful accelerators in existence. They have accelerated electron bunches of several kiloamperes, and are being investigated as drivers for heavy ion driven inertial confinement fusion (HIF), which requires peak beam currents of kiloamperes and average beam powers of some tens of megawatts. The requirement for waste transmutation with an 800 MeV proton or deuteron beam with an average current of 50 mA and an average power of 40 MW lies midway between the electron machines and the heavy ion machines in overall difficulty. Much of the technology and understanding of beam physics carries over from the previous machines to the new requirements. The induction linac allows use of a very large beam aperture, which may turn out to be crucial to reducing beam loss and machine activation from the beam halo. The major issues addressed here are transport of high intensity beams, availability of sources, efficiency of acceleration, and the state of the needed technology for the waste treatment application. Because of the transformer-like action of an induction core and the accompanying magnetizing current, induction linacs make the most economic sense and have the highest efficiencies with large beam currents. Based on present understanding of beam transport limits, induction core magnetizing current requirements, and pulse modulators, the efficiencies could be very high. The study of beam transport at high intensities has been the major activity of the HIF community. Beam transport and sources are limiting at low energies but are not significant constraints at the higher energies. As will be shown, the proton beams will be space-charge-dominated, for which the emittance has only a minor effect on the overall beam diameter but does determine the density falloff at the beam edge.

6934 (NIFS-MEMO–13) **Electron beam irradiation test facility for research and development of plasma facing components.** Kubota, Yusuke; Noda, Nobuaki; Sagara, Akio; Inoue, Noriyuki; Akaishi, Kenya; Motojima, Osamu. National Inst. for Fusion Science, Nagoya (Japan). Mar 1994. 59p. (In Japanese). Order Number DE95737218. Source: OSTI; NTIS; INIS.

To develop a reliable divertor plate for large helical device(LHD), a test facility called ACT(Active Cooling Teststand) has been constructed in Toki site. The facility can generate 100 kW electron beams with beam energy of 30 keV as a heat source, which can irradiate with a heat flux of up to 100 MW/m^2 to a test sample piece steadily. The beam irradiation area on the sample can be changed from 1 to 400 cm^2 with a 64 step controller electrically. By using the ACT, the thermal fatigue tests of various kinds of carbon-copper brazed components are being performed under the heat loads of 2.5-14 MW/m^2. The test results show that several brazed components are applicable as the divertor plates for the first stage of LHD operation, namely with maximum heat load of 10 MW/m^2 for 5 seconds discharge durations. (author).

6935 (SAND–94-1419C) **Pulsed power drivers for ICF and high energy density physics.** Ramirez, J.J.; Matzen, M.K.; McDaniel, D.H. Sandia National Labs., Albuquerque, NM (United States). [1995]. 17p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9411152–1: International Atomic Energy Agency (IAEA) technical committee meeting on drivers for inertial confinement fusion, Paris (France), 14-18 Nov 1994). Order Number DE95003361. Source: OSTI; NTIS; INIS; GPO Dep.

Nanosecond Pulsed Power Science and Technology has its origins in the 1960s and over the past decade has matured into a flexible and robust discipline capable of addressing key physics issues of importance to ICF and high Energy Density Physics. The major leverage provided by pulsed power is its ability to generate and deliver high energy and high power at low cost and high efficiency. A low-cost, high-efficiency driver is important because of the very large capital investment required for multi-megajoule ignition-class systems. High efficiency is of additional importance for a commercially viable inertial fusion energy option. Nanosecond pulsed power has been aggressively and successfully developed at Sandia over the past twenty years. This effort has led to the development of unique multi-purpose facilities supported by highly capable diagnostic, calculational and analytic capabilities. The Sandia Particle-beam Fusion Program has evolved as part of an integrated national ICF Program. It applies the low-cost, high-efficiency leverage provided by nanosecond pulsed power systems to the longer-term goals of the national program, i.e., the Laboratory Microfusion Facility and Inertial Fusion Energy. A separate effort has led to the application of nanosecond pulsed power to the generation of intense, high-energy laboratory x-ray sources for application to x-ray laser and radiation effects science research. Saturn is the most powerful of these sources to date. It generates ~500 kilojoules of x-rays from a magnetically driven implosion (Z-pinch). This paper describes results of x-ray physics experiments performed on Saturn, plans for a new Z-pinch drive capability for PBFA-II, and a design concept for the proposed ~15 MJ Jupiter facility. The opportunities for ICF-relevant research using these facilities will also be discussed.

6936 (UCRL-ID–117884) **Use of the National Ignition Facility for defense, energy, and basic research science.** Logan, B.G. Lawrence Livermore National Lab., CA (United States). 15 Jul 1994. 31p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95002319. Source: OSTI; NTIS; GPO Dep.

On January 15, 1993, the Department of Energy (DOE) approved the Justification for Mission Need (JMN) for the National Ignition Facility (NIF). This action (Key Decision Zero, or KD0) commenced the conceptual design for the facility, which has resulted in a recently completed Conceptual Design Report (CDR). The JMN document defined the NIF mission elements to include laboratory fusion ignition and energy gain, weapons physics, and nuclear weapons effects testing research (NWET). NIF has a dual benefit by contributing to inertial fusion energy (IFE), industrial technology development, new basic science areas applying high power lasers, and training young scientists for future stewardship activities. For consideration of the next DOE action, Key Decision One (KD1), all mission elements of the NIF as stated in the JMN are consistent with and important to the US stockpile stewardship program, and are expected to continue to be in the vital interest of the United States for the long term. This document provides further information on the utility of NIF for stockpile stewardship, including support for a Comprehensive Test Ban Treaty (CTBT), and specific findings of four national workshops on the NIF utility for weapons physics, NWET, IFE and basic science research. The role of NIF for stockpile stewardship has been refined since a DOE meeting in Albuquerque, NM Feb. 1–2, 1994. The possible compliance of NIF research with anticipated CTBT and NPT limitations was discussed at the DOE Office of Arms Control and Nonproliferation in Washington, DC on March 8, 1994.

6937 (UCRL-ID–118982) **Using and programming the SUPERCODE.** Haney, S.W. Lawrence Livermore National Lab., CA (United States). 8 Jun 1994. 304p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95004342. Source: OSTI; NTIS; GPO Dep.

SUPERCODE is a systems code used in designing tokamak devices and reactors. This report is divided into 4 chapters. Chapter one covers installing the code and directory organization. The execution of the code, command line editing and history, the shell language, classes, and shell input and output are discussed in chapter two. Chapter three covers the writing modules. In chapter four, the Consts module, Sys module, and Plot module are covered. At the end of the report, the need and use of SUPERCODE are summarized.

6938 (UCRL-JC–115491) **UEDGE and DEGAS modeling of the DIII-D scrape-off layer plasma.** Genstermacher, M.E. (Lawrence Livermore National Lab., CA (United States)); Porter, G.D.; Rensink, M.E.; Rognlien, T.D.; Allen, S.L.; Hill, D.N.; Lasnier, C.J.; Leonard, T.; Petrie, T. Lawrence Livermore National Lab., CA (United States); General Atomics, San Diego, CA (United States). May 1994. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC03-89ER51114. (CONF-940580–23: 11. international conference on plasma surface interactions in controlled fusion devices, Mito (Japan), 23-27 May 1994). Order Number DE95003652. Source: OSTI; NTIS; INIS; GPO Dep.

This paper presents the results of work to develop benchmarked theoretical models of scrape-off-layer (SOL) characteristics in diverted tokamaks by comparing shot simulations using the UEDGE plasma fluid and DEGAS Monte-Carlo neutral particle transport codes to measurements of the DIII-D SOL plasma. The available experimental data include the radial profiles of electron density and temperature, the ion temperature, the divertor exhaust power, the intensity of H_α emission, and profiles of the radiated power. A very simple model of the anomalous perpendicular transport rates produces consistency between the calculated and measured radial profiles of the divertor power, and of the midplane densities and temperatures. Experimentally, measured exhaust power is now typically 80–90% of the input power. The simulated peak power on the outer leg of the divertor floor is now within about 20% of the measured power. Various sensitivities of the simulation and measurement comparisons to model assumptions are described. Finally, these benchmarked models have been used to examine the effects of various baffle configurations for the Radiative Divertor Upgrade in DIII-D.

6939 (UCRL-JC–115492) **Divertor design for the Tokamak Physics Experiment.** Hill, D.N. (Lawrence Livermore National Lab., CA (United States)); Braams, B.; Brooks, J.N. Lawrence Livermore National Lab., CA (United States); Princeton Univ., NJ (United States). Plasma Physics Lab. May 1994. 39p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48 ; AC02-76CH03073. (CONF-940580–22: 11. international conference on plasma surface interactions in controlled fusion devices, Mito (Japan), 23-27 May 1994). Order Number DE95003653. Source: OSTI; NTIS; INIS; GPO Dep.

In this paper we discuss the present divertor design for the planned TPX tokamak, which will explore the physics and technology of steady-state (1000s pulses) heat and particle removal in high confinement (2–4 × L-mode), high beta ($\beta_N \geq 3$) divertor plasmas sustained by non-inductive current drive. The TPX device will operate in the double-null divertor configuration, with actively cooled graphite targets forming a deep (0.5 m) slot at the outer strike point. The peak heat flux on, the highly tilted (74° from normal) re-entrant (to recycle ions back toward the separatrix) will be in the range of 4–6 MW/m^2 with 18 MW of neutral beams and RF heating power. The combination of active pumping and gas puffing (deuterium plus impurities), along with higher heating power (45 MW maximum) will allow testing of radiative divertor concepts at ITER-like power densities.

6940 (UCRL-JC–116030) **Target injection methods for inertial fusion energy.** Petzoldt, R.W.; Moir, R.W. Lawrence Livermore National Lab., CA (United States). Jun 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940630–52: 11. topical meeting on the technology of fusion energy, New Orleans, LA (United States), 19-24 Jun 1994). Order Number DE95003654. Source: OSTI; NTIS; INIS; GPO Dep.

We have studied four methods to inject IFE targets: the gas gun, electrostatic accelerator, induction accelerator, and rail gun. We recommend a gas gun for indirect drive targets because they can support a gas pressure load on one end and can slide along the gun barrel without damage. With the gas gun, the amount of gas required for each target (about 10 to 100 mg) is acceptable; for other types of targets, a sabot would be necessary. A cam and poppet valve arrangement is recommended for gas flow control. An electrostatic accelerator is attractive for use with lightweight spherical direct drive targets. Since there is no physical contact between the target and the injector, there will be no wear of either component during the injection process. An induction accelerator has an advantage of no electrical contact between the target and the injector. Physical contact is not even necessary, so the wear should be minimal. It requires a cylindrical conductive target sleeve which is a substantial added mass. A rail gun is a simpler device than an electrostatic accelerator or induction accelerator. It requires electrical contact between the target and the rails and may have a significant wear rate. The wear in a vacuum could be reduced by use of a solid lubricant such as MoS_2. The total required accuracy of target injection, tracking and beam pointing of ±0.4 mm appears achievable but will require development and experimental verification.

6941 (UCRL-JC–117669) **Flow-through Z-pinch study for radiation generation and fusion energy production.** Hartman, C.W. (Lawrence Livermore National Lab., CA (United States)); Eddleman, J.L.; Moir, R.; Shumlak, U. Lawrence Livermore National Lab., CA (United States). 20 Jun 1994. 5p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940630–51: 11. topical meeting on the technology of fusion energy, New Orleans, LA (United States), 19-24 Jun 1994). Order Number DE95004209. Source: OSTI; NTIS; INIS; GPO Dep.

We discuss a high-density fusion reactor which utilizes a flow-through Z pinch magnetic confinement configuration. Assessment of this reactor system is motivated by simplicity and small unit size (few hundred MWe) and immunity to plasma contamination made possible at high density. The type reactor discussed here would employ a liquid Li vortex as the first wall/blanket to capture fusion neutrons with minimum induced radioactivity and to achieve high wall loading and a power density of 200 w/cm^3.

6942 (UCRL-JC–118496) **The physics design of the Tokamak Physics Experiment.** Thomassen, K.I. (Lawrence Livermore National Lab., CA (United States)); Batchelor, D.B.; Bialek, J. Lawrence Livermore National Lab., CA (United States). 8 Aug 1994. 9p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-940933–16: 15. international conference on plasma physics and controlled nuclear fusion research, Seville (Spain), 26 Sep - 1 oct 1994). Order Number DE95003649. Source: OSTI; NTIS; INIS; GPO Dep.

The physics approaches to improved, steady-state tokamak reactors, as evolved through reactor design studies, ideas based on experimental results, and better theoretical understanding, are the foundation for the mission and physics design of the Tokamak Physics Experiment (TPX). The mission of TPX is to develop the scientific basis for cost-competitive, continuously operating tokamak power plants. We report here the design status of TPX, a device optimized to achieve improved performance through strong plasma shaping, recycling control, and current profile shaping, while operating continuously. The design incorporates poloidal field flexibility for a wide range of operation in normalized beta and internal inductance, a double-null "Vee" divertor configuration for power and particle control, internal and external $n \neq 0$ coils, as well as passive stabilizers, for control of MHD activity, and remote maintenance for continuous high-power operation in deuterium. Having superconducting poloidal and toroidal coils, the TPX device itself is capable of continuous operation, although initially auxiliary equipment limits the pulse length to 1000 sec.

99 GENERAL AND MISCELLANEOUS

6943 (CONF-9310375–1) **Environmental site assessment.** Tate, L.R. Tennessee Valley Authority, Muscle Shoals, AL (United States). [1993]. 3p. Sponsored by Tennessee Valley Authority, Knoxville, TN (United States). (Z–346). From Pollution prevention education for agri-chem dealers and farmers; Columbia, MO (United States); 5-6 Oct 1993. Order Number DE95001727. Source: OSTI; NTIS.

Short communication. SITE CHARACTERIZATION/training; TRAINING; RECOMMENDATIONS

6944 (DOE/ER/75776–T1) **Attracting students and professionals into math, science, and technology education at the elementary and middle grades: Annual report, September 1, 1992–August 31, 1993.** Flick, L.B. Washington State Univ., Pullman, WA (United States). [1995]. 10p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-92ER75776. Order Number DE95004295. Source: OSTI; NTIS; GPO Dep.

This report describes the progress of a project to encourage students and professionals to participate in math, science, and technology education at the elementary and middle grades. The topics of the report include developing a model laboratory/classroom for teacher education, providing financial incentives for students with technical majors to complete the program, and emphasizing issues of equity and minority participation in mathematics, science and technology education through recruitment procedures and in course content.

6945 (DOE/ER/75776–T2) **Attracting students and professionals into math, science, and technology education at the elementary and middle grades: Final report, September 1, 1992–February 28, 1994.** Flick, L.B. Washington State Univ., Pullman, WA (United States). [1995]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG06-92ER75776. Order Number DE95004296. Source: OSTI; NTIS; GPO Dep.

This report describes the progress of a project to encourage students and professionals to participate in math, science, and technology education at the elementary and middle grades. The topics of the report include documenting activities and procedures for the purposes of evaluation and dissemination of descriptive information, generating case studies of the students going through this program to provide research and evaluation data on the process of attracting technically qualified people into elementary and middle school teaching, establishing a program of mentoring between scientists, engineers, and mathematicians and prospective teachers in the program, and establishing a program of mentoring between master teachers in area schools and prospective teachers.

6946 (DOE/HR–0098) **Department of Energy 1977–1994: A summary history.** Energy history series. Fehner, T.R.; Holl, J.M. USDOE Office of Administration and Human Resource Management, Washington, DC (United States). History Div. Nov 1994. 142p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

The Department of Energy Organization Act of 1977 created perhaps the most interesting and diverse agency in the Federal Government. The new department brought together for the first time not only most of the government's energy programs but also defense responsibilities that included the design, construction, and testing of nuclear weapons. The Department of Energy incorporated a score of organizational entities from a dozen departments and agencies, each with its own history and traditions. Uniting these seemingly disparate entities and programs was a common commitment to performing first rate science and technology. The Department of Energy sought–and continues to seek–to be one of the Nation's premier science and technology organizations. The Department of Energy, 1977–1994, is a summary history of the origins, goals, and achievements of the Department and selected major programs. Beginning with the various fuels policies on the energy side and the Manhattan project on the defense side, the study details how the Department was born of the energy crisis of the early and mid-1970s. The history then surveys the Department and its programs from the Carter through the Clinton administrations. As the energy crisis eased, the Department played a central role on issues as dissimilar as the Strategic Defense Initiative and the Superconducting Super Collider. With the end of the Cold War, the Department of Energy further transformed itself, moving from the building of bombs to partial dismantlement of the nuclear weapons complex and to an increased emphasis on environmental activities and technology transfer efforts.

6947 (LA-UR–94-3653) **Color orthophotography: To scan or not.** Benson, J.L. Los Alamos National Lab., NM (United States). [1994]. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950364–1: 1994 ASPRS/ACSM technical program, Bethesda, MD (United States), 2 Mar 1995). Order Number DE95002749. Source: OSTI; NTIS; GPO Dep.

A picture is worth a thousand words, which explains why digital orthophotographs have become such a popular item. Today, most procurement of orthophotographs result in a digital product. However, if one already has hard copy orthophotography, should one scan them, or have them produced as true digital orthophotographs? What are the advantages and disadvantages of each methodology? This paper examines the procedure the Facility for Information Management, Analysis, and Display (FIMAD) at Los Alamos National Laboratory (LANL) uses to determine the appropriate product based on our needs. The scanned product is compared to a digitally produced orthophotograph, procured through a vendor. Comparison is performed on the screen, on hard copy output, and by spectral analysis in the red, green and blue bands. Full screen sized images look fairly good, but when enlarged, the scanned image appeared blocky and fuzzy. Hard copy output from the electrostatic plotter produces colors similar to the screen for the demo image, but renders poor color matching with the scanned image. Histograms of each band of the scanned image show a high count at the low end of the curve. These findings confirm that the images are different, and that the differences are not just in the eyes of the beholder. It was concluded true digital orthophotographs are needed.

6948 (UCRL–52000-94-8/9) **Energy and Technology Review, August–September 1994.** Bookless, W.A. Lawrence Livermore National Lab., CA (United States). [1994]. 41p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Order Number DE95004248. Source: OSTI; NTIS; GPO Dep.

This issue contains an overview on materials by computer design; research highlights on using computers to build better computers, modeling large molecular systems, massively parallel computing CRADA, designing better microelectronics devices, and polymeric nitrogen for storing energy; and feature articles on nanotribology (modeling atoms when surfaces collide), understanding material surfaces and interfaces, and predicting the structural and electronic properties of scintillators. The feature articles are processed separately for the database.

9901 Management

Refer also to citation(s) 5136, 5137, 5141, 5142, 5230, 5239, 5476, 7070, 7077

6949 (DOE/IG–0001/95) **US Department of Energy Office of Inspector General semiannual report to Congress, April 1–September 30, 1994.** USDOE Office of Inspector General, Washington, DC (United States). Oct 1994. 84p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003981. Source: OSTI; NTIS; GPO Dep.

This Office of Inspector General Semiannual Report to the Congress covers the period from April 1 through September 30, 1994. The report summarizes significant audit, inspection and investigate accomplishments for the reporting period, a large portion of which evaluated management controls that the Department of Energy uses to ensure efficient and effective operation of its programs. During this reporting period, the Office of Inspector General issued 64 audit and 15 inspection reports. The Office of Inspector General also provided 11 investigative referrals to management for recommended positive action. As a result of audits of contract costs, the Office of Inspector General questioned $553,852 in costs. Management committed to taking corrective actions which the Office of Inspector General estimates will result in a more efficient use of funds totaling $467 million. For reports issued during the period, the Office of Inspector General made audit recommendations that, when implemented by management, could result in $568 million being put to better use. In addition, the Office of Inspector General's investigations led to 16 criminal convictions and one pretrial diversion, as well as criminal and civil prosecutions which resulted in fines and recoveries of $160,301,663.

6950 (DOE/IG–0360) **Audit of the transfer of government-owned property at the Mound and Pinellas Plants.** USDOE Office of Inspector General, Washington, DC (United States). Nov 1994. 16p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

This report addresses the audit of the transfer of government-owned property at the Mound and Pinellas Plants. The end of the Cold War brought many changes to the Department of Energy (Department), including the reconfiguration of defense program activities and the closure of some operations. Public Law 103-160 allows the Department to transfer or lease, under specified conditions, Department-owned personal property to economic development initiatives. By encouraging economic development, the Department hopes to mitigate adverse impacts that plant closures would have on local economies. The objective of the audit was to determine whether the Department's interests were properly protected with regard to the transfer of equipment from weapons

production use to economic development initiatives. The Mound Plant (Mound) and the Pinellas Plant (Pinellas) did not have property disposition plans that would properly protect Departmental interests. Specifically, Mound planned to make about $13.2 million of Government-owned property available to private businesses even through the property was needed by Defense Programs at other facilities and would cost less than $1 million to relocate. In addition, Mound and Pinellas planned to make available to economic development initiatives several hundred million dollars of Government-owned property without first determining whether it was needed by other Departmental elements. These conditions existed because neither Headquarters nor the Albuquerque Operations Office provided Mound and Pinellas adequate guidance, and Mound and Pinellas management believed that economic development initiatives could take precedence over some Departmental programs.

6951 (DOE/IG–0362) **Audit of light vehicle fleet management in the Department of Energy.** USDOE Office of Inspector General, Washington, DC (United States). Dec 1994. 21p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

This report addresses the audit of light vehicle fleet management in the Department of Energy (DOE). The DOE is responsible for managing its overall vehicle fleet operations, including the light vehicle fleet. The DOE's two methods of fleet operations are to use vehicles that are owned and managed by the DOE, or to use vehicles that are leased from outside sources such as the General Services Administration (GSA), but still managed by the DOE. The objective of this audit was to evaluated the economy and efficiency of the DOE's light vehicle operations. The audit disclosed that the Department was not managing its light vehicle fleet operations in the most economical and efficient manner. Even through DOE operations offices established local use standards which were substantially below suggested Department guidelines, about 46% of the vehicles reviewed (5,999) did not meet these lower utilization standards. Further, analyses at selected DOE sites showed that GSA owned fleets were more economical and efficient than DOE owned fleets. These conditions occurred because neither the DOE nor its operations offices were effectively monitoring vehicle utilization of ensuring that vehicle operations were conducted in the most economical and efficient manner. In the auditors' opinion, a 10% reduction in the light vehicle fleet could potentially save the DOE $7 million in vehicle acquisition costs and $3 million annually in reduced operating and maintenance costs, subject to certain offsetting costs discussed in the report. The auditors recommended that the DOE monitor vehicle utilization to ensure that the minimum number of vehicles are retained to meet mission needs, and determine and use the most economical and efficient method of operating the vehicle fleets. Management generally concurred with the findings and recommendations, and provided information on planned corrective actions.

6952 (DOE/IG–0363) **Inspection of administrative management procedures for legal services acquired by selected management and operating contractors.** USDOE Office of Inspector General, Washington, DC (United States). Dec 1994. 46p. Sponsored by USDOE, Washington, DC (United States). Source: OSTI (Free of Charge).

The initial purpose of this inspection was to evaluate the administrative management of legal services relating to civil litigation acquired by Rockwell International Corporation (Rockwell) under the Management and Operating (M and O) Contract No. DE-AC04-76DP03533. This contract was for the operation of the Rocky Flats Plant, and Rockwell's continuing obligations under this contract are being administered by the Albuquerque Operations Office for the purpose of closing out Rockwell's activities at Rocky Flats. In order to determine whether the findings generally applied to other DOE sites, the auditors also conducted a limited evaluation of the management procedures relating to legal services for three other selected M and O contractors. The purpose of this inspection was to evaluate: (1) Rockwell's acquisition and administration of legal services associated with civil litigation of Rocky Flats under Contract No. DE-AC04-76DP03533, and the processes used by Rockwell and the Albuquerque Operations Office (Albuquerque) for reviewing the cost of these services under DOE's voucher system prior to payment. (2) The acquisition and administration of outside legal services at Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and Sandia National Laboratories (SNL), Albuquerque. (3) The March 23, 1994, DOE Litigation Management Procedures as they relate to the management to litigation involving Management and Operating contractors.

6953 (INIS-mf–14418) **Guidebook on training to establish and maintain the qualification and competence of nuclear power plant operations personnel.** Bezpecnost Jadernych Zarizeni, no.6. Statni Urad pro Jadernou Bezpecnost, Prague (Czech Republic). 1994. 197p. Translation of IAEA TECDOC 525, Vienna, 1989. (In Czech). Order Number DE95611424. Source: OSTI; NTIS (US Sales Only); INIS.

Since the IAEA published its Guidebook on the Qualification of Nuclear Power Plant Operations Personnel in 1984 (Technical Reports Series 242) there have been important developments in the approach to training adopted by many operating organizations in different countries. It is now accepted that developing training programmes based solely on experience is inappropriate for the nuclear power industry, and that a systematic approach to training is necessary. It has been recognized that inadequate knowledge and skills may lead to human errors, and it is therefore necessary to review and improve the development and implementation of initial and continuing training programmes. The present Guidebook proposes an approach which is comprehensive and systematic in its methodology and also cost effective in its implementation. This Guidebook is mainly intended for management and training staff of nuclear power plant operating organizations. Relevant examples of current training practices are presented in the Appendices, which constitute an integral part of the Guidebook. (author).

6954 (INS-T–529) **VHS-tape system for general purpose computer. For next generation mass storage system.** Ukai, K.; Takano, M.; Shinohara, M.; Niki, K.; Suzuki, Y.; Hamada, T.; Ogawa, M. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jul 1994. 24p. (In Japanese). Order Number DE95737268. Source: OSTI; NTIS; INIS.

Mass storage is one of the key technology of next generation computer system. A huge amount of data is produced on a field of particle and nuclear physics. These data are raw data of experiments, analysis data, Monte Carlo simulations data, etc. We search a storage device for these data at the point of view of capacity, price, size, transfer speed, etc. We have selected a VHS-tape (12.7 mm-tape, helical scan) from many storage devices. Characteristics of the VHS-tape are as follows; capacity of 14.5 GB, size of 460 cm^3, price of 1,000 yen (S-VHS tape for video use), and 1.996 MB/sec transfer speed at a sustained mode. Last year, we succeeded to operate the VHS-tape system on a workstation as a I/O device with read/write speed of 1.5 MB/sec. We have tested a VHS-tape system by connecting to the channel of the general purpose computer (Fujitsu M-780/10S) in our institute. We obtained a read and write speeds of 1.07 MB/sec and 1.72 MB/sec by FORTRAN test programs, respectively. Read speeds of an open reel tape and a 3480 type cassete tape by the same test programs are 1.13 MB/sec and 2.54 MB/sec, respectively. Speeds of write operation are 1.09 MB/sec and 2.54 MB/sec for the open reel and 3480 cassete tape, respectively. A start motion of the VHS-tape for read/write operations needs about 60 seconds. (author).

6955 (JAERI-Conf–94-004) **Report of the 1993 workshop on particle-material interactions for fusion.** Japan Atomic Energy Research Inst., Tokyo (Japan). Nov 1994. 195p. (In Japanese, English). (CONF-9403189–: 1993 workshop on particle-material interactions for fusion, Tokai (Japan), 8-9 Mar 1994). Order Number DE95737282. Source: OSTI; NTIS; INIS.

This publication is the collection of the papers presented at the title meeting. The 16 of the presented papers are indexed individually. (J.P.N.).

9902 Mathematics and Computers

Refer also to citation(s) 5209, 5240, 5241, 5269, 5337, 5420, 5454, 5468, 5471, 5478, 5480, 5629, 5647, 5732, 5752, 5871,

5899, 5900, 5901, 5917, 5923, 5933, 5935, 5937, 5938, 5939, 5940, 5941, 5942, 5943, 5944, 5945, 5946, 5947, 5948, 5949, 5951, 5953, 5955, 5958, 5963, 6001, 6147, 6213, 6239, 6314, 6317, 6318, 6319, 6320, 6339, 6340, 6343, 6345, 6402, 6404, 6410, 6428, 6469, 6472, 6487, 6494, 6517, 6567, 6593, 6635, 6654, 6784, 6785, 6810, 6811, 6937, 7068, 7069

6956 (ANL–93/30) **Users manual for KSP data-structure-neutral codes implementing Krylov space methods.** Gropp, W. (Argonne National Lab., IL (United States)); Smith, B. Argonne National Lab., IL (United States). Aug 1994. 41p. Sponsored by USDOE, Washington, DC (United States);Department of Defense, Washington, DC (United States). DOE Contract W-31109-ENG-38. Contract ONR N0001492-J1890. Order Number DE95004265. Source: OSTI; NTIS; GPO Dep.

The combination of a Krylov space method and a preconditioner is at the heart of most modern numerical codes for the iterative solution of linear systems. This document contains both a users manual and a description of the implementation for the Krylov space methods package KSP included as part of the Portable, Extensible Tools for Scientific computation package (PETSc). PETSc is a large suite of data-structure-neutral libraries for the solution of large-scale problems in scientific computation, in particular on massively parallel computers. The methods in KSP are conjugate gradient method, GMRES, BiCG-Stab, two versions of transpose-free QMR, and others. All of the methods are coded using a common, data-structure-neutral framework and are compatible with the sequential, parallel, and out-of-core solution of linear systems. The codes make no assumptions about the representation of the linear operator; implicitly defined operators (say, calculated using differencing) are fully supported. In addition, unlike all other iterative packages we are aware of, the vector operations are also data-structure neutral. Once certain vector primitives are provided, the same KSP software runs unchanged using any vector storage format. It is not restricted to a few common vector representations. The codes described are actual working codes that run on a large variety of machines including the IBM SP1, Intel DELTA, workstations, networks of workstations, the TMC CM-5, and the CRAY C90. New Krylov space methods may be easily added to the package and used immediately with any application code that has been written using KSP; no changes to the application code are needed.

6957 (ANL/MCS-TM–164) **Getting started with ADIFOR.** Bischof, C. (Argonne National Lab., IL (United States). Mathematics and Computer Science Div.); Corliss, G.; Griewank, A.; Hovland, P.; Carle, A. Argonne National Lab., IL (United States). Mathematics and Computer Science Div. Jun 1993. 38p. Sponsored by USDOE, Washington, DC (United States);National Science Foundation, Washington, DC (United States);National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-31109-ENG-38. Order Number DE95004143. Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.

ADIFOR is a source translator that, given a collection of subroutines to compute a function f, generates Fortran 77 code for computing the derivatives of this function. This paper describes step by step how to use ADIFOR to generate derivative code. It also describes common misunderstandings as well as workarounds for current shortcomings. Familiarity with UNIX™ and Fortran 77 is assumed. Also desirable is a basic understanding of automatic differentiation. ADIFOR is a research project, and thus likely to be subject to many changes. This document will change to reflect the ADIFOR changes. New users are advised to make sure that the manual version in hand is the current up-to-date one.

6958 (CIEMAT–741) **Camac Software for TJ-I and TJ-IU.** Milligen, B. P. van. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 40p. Order Number DE95722435. Source: OSTI; NTIS; INIS.

A user-friendly software package for control of CAMAC data acquisition modules for the TJ-I and TJ-IU experiments at the Association CIEMAT para Fusion has been developed. The CAMAC control software operates in Synchronization with the pre-existing VME-based data-acquisition system. The control software controls the setup of the CAMAC modules and manages the data flow from the taking to the storage of data. Data file management is performed largely automatically. Further, user software is provided for viewing and analysing the data.

6959 (CIEMAT–746) **Fitting of two and three variate polynomials from experimental data through the least squares method.** Sanchez-Miro, J.J.; Sanz-Martin, J.C. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). [1994]. 33p. (In Spanish). Order Number DE95722440. Source: OSTI; NTIS; INIS.

Obtaining polynomial fittings from observational data in two and three dimensions is an interesting and practical task. Such an arduous problem suggests the development of an automatic code. The main novelty we provide lies in the generalization of the classical least squares method in three FORTRAN 77 programs usable in any sampling problem. Furthermore, we introduce the orthogonal 2D-Legendre function in the fitting process. These FORTRAN 77 programs are equipped with the options to calculate the approximation quality standard indicators, obviously generalized to two and three dimensions (correlation nonlinear factor, confidence intervals, cuadratic mean error, and so on). The aim of this paper is to rectify the absence of fitting algorithms for more than one independent variable in mathematical libraries.

6960 (CIEMAT–749) **METEOR v1.0 : design and structure of the software package.** Palomo, E. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 71p. (In Spanish). Order Number DE95730397. Source: OSTI; NTIS.

This script describes the structure and the separated modules of the software package METEOR for the statistical analysis of meteorological data series. It contains a systematic description of the subroutines of METEOR and, also, of the required shape for input and output files. The original version of METEOR have been developed by Ph.D. Elena Palomo, CIEMAT-IER, GIMASE. It is built by linking programs and routines written in FORTRAN 77 and it adds the graphical capabilities of GNUPLOT. The shape of this toolbox was designed following the criteria of modularity, flexibility and agility criteria. All the input, output and analysis options are structured in three main menus: (i)the first is aimed to evaluate the quality of the data set; (ii) the second is aimed for pre-processing of the data; and (iii) the third is aimed towards the statistical analyses and for creating the graphical outputs. Actually the information about METEOR is constituted by three documents written in spanish: (1) METEOR v1.0: User's guide, (2) METEOR v1.0: A usage example; (3) METEOR v1.0: Design and structure of the software package. (Author)

6961 (CIEMAT–750) **METEOR v1.0 : a usage example.** Palomo, E. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 69p. (In Spanish). Order Number DE95730398. Source: OSTI; NTIS.

This script a detailed example of the use the software package METEOR for statistical analysis of meteorological data series. A real spanish meteorological data set is chosen to show the capabilities of METEOR. Output files and resultant plots provided of their interpretations are compiled in three appendixes. The original version of METEOR have been developed by Ph. D. Elena Palomo, CIEMAT-IER, GIMASE. It is built by linking programs and routines written in Fortran 77 and it adds the graphical capabilities of GNUPLOT. The shape of this toolbox was designed following the criteria of modularity, flexibility and agility criteria. All the input, output and analysis options are structured in three main menus: (i) The first is aimed to evaluate the quality of the data set; (ii) the second is aimed for pre-processing of the data; and (iii) the third is aimed towards the statistical analysis and for creating the graphical outputs. Actually the information about METEOR is constituted by three documents written is spanish: (1) METEOR v1.0: User's guide; (2) METEOR v1.0: A usage example; (3) METEOR v1.0: Design and structure of the software package. (Author)

6962 (CIEMAT–751) **METEOR v1.0 : user's guide.** Palomo, E. Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Madrid (Spain). 1994. 54p. (In Spanish). Order Number DE95730399. Source: OSTI; NTIS.

This script is a User's Guide for the software package METEOR for statistical analysis of meteorological data series. The original version of METEOR have been developed by Ph.D. Elena Palomo, CIEMAT-IER, GIMASE. It is built by linking programs and routines written in Fortran 77 and it adds the graphical capabilities of GNUPLOT. The shape of this toolbox was designed following the criteria of modularity, flexibility and agility criteria. All the input, output and analysis options are structured in three main menus: (i) the first is aimed to evaluate the quality of the data set; (ii) The second is aimed for pre-processing of the data, and (iii) the third is aimed towards the statistical analyses and for creating the graphical outputs. Actually the information about METEOR is constituted by three documents written in spanish: (1) METEOR v1.0: User's guide; (2) METEOR v1.0: A usage example; (3) METEOR v1.0. Design and structure of the software package. (Author)

6963 (CONF-9405111–, pp. Paper 3, 1-8) **Binary authentification signatures integrity standard: System file integrity for the masses.** Bartoletti, T. (Texas A&M Univ., College Station, TX (United States)); Schales, D.; Graff, M. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Trusted software plays a central role in computer security, yet straightforward methods for authentification of installed software are lacking in the marketplace. This paper argues for a vendor-supported standard for the generation and publication of strong digital signatures for all vendor-supplied system files. Progress in the design and adoption of a proposed standard is discussed.

6964 (CONF-9405111–, pp. Paper 4, 1-8) **Security evaluation of smartcard systems.** Beuting, F.; Baumgart, R. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

RWTUEV can perform all checks both with regard to the Security and the Safety of smartcard systems. With evidence of these checks, such systems are upgraded, which promotes confidence in an acceptance of these technologies. As was shown above, these tests can be regarded as part of the development of high-quality information security.

6965 (CONF-9405111–, pp. Paper 5, 1-2) **Policies for implementing network firewalls.** Brown, C.D. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Corporate networks are frequently protected by 'firewalls' or gateway systems that control access to/from other networks, e.g., the Internet, in order to reduce the network's vulnerability to hackers and other unauthorized access. Firewalls typically limit access to particular network nodes and application protocols, and they often perform special authentification and authorization functions. One of the difficult issues associated with network firewalls is determined which applications should be permitted through the firewall. For example, many networks permit the exchange of electronic mail with the outside but do not permit file access to be initiated by outside users, as this might allow outside users to access sensitive data or to surreptitiously modify data or programs (e.g., to install Trojan Horse software). However, if access through firewalls is severely restricted, legitimate network users may find it difficult or impossible to collaborate with outside users and to share data. Some of the most serious issues regarding firewalls involve setting policies for firewalls with the goal of achieving an acceptable balance between the need for greater functionality and the associated risks. Two common firewall implementation techniques, screening routers and application gateways, are discussed below, followed by some common policies implemented by network firewalls.

6966 (CONF-9405111–, pp. Paper 6, 1-12) **Lockheed testing program of the Motorola Network Encryption System (NES).** Capell, J. (Lockheed Missiles & Space Co., Inc., Sunnyvale, CA (United States)); Gentile, K.; LaPlant, G. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The requirement to provide a means for transmitting classified and unclassified data over shared public and private networks led several Lockheed companies to adopt the Motorola Network Encryption System (NES) for encryption. This device encrypts data within a datagram, leaving vital addressing information in the clear. As a result, NES encrypted data may be transmitted along with unclassified data on shared networks. In terms of performance, Motorola claims that the maximum throughput of the NES is 800 KBPS from the Ethernet port on the red side to the Ethernet port on the black side. Preliminary Local Area Network testing of the NES by Lockheed Missiles & Space Co., (LMSC) demonstrated that throughout over the LAN was somewhat slower. However, there was insufficient information available about connectivity and performance characteristics of this new COMSEC device over public networks. In order to determine whether the NES could be incorporated into existing and future networks, LMSC led a testing program with participants from Lockheed Aeronautical Systems Co. (LASC), Lockheed Sanders Co., GE Aircraft Engine Co. (GEAE), and Motorola. The goal of the testing program was to determine the connectivity and performance characteristics of the NES on public Wide Area Networks: Frame Relay, ISDN to Switched 56, and X.25. The testing program demonstrated that when connecting to a Cisco Systems network router, the NES is capable of operating over all networks tested. The performance varied by several factors: type of workstation, communications software, and packet size. Once packet size was controlled to avoid fragmentation performance was optimized. In conclusion, the NES testing program was a success.

6967 (CONF-9405111–, pp. Paper 7, 1) **FIPS 140-1, 46-2, and 185.** Carnahan, L. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Cryptography can be used to provide integrity and confidentiality for information processed and stored by automated electronic applications. Cryptography can also be used for the generation and verification of electronic signatures in these systems. For application developers who have determined a need to utilize cryptography to protect electronic information, the next step is a perplexing one. How does a developer or implementor select a cryptographic module? What requirements should be met to provide proper security features for a module implementing security? Federal Information Processing Standard (FIPS) 140-1, Security Requirements for Cryptographic Modules helps address these issues. A cryptographic module which is designed to meet FIPS

140-1 incorporates FIPS approved cryptographic algorithms and functions specified in related FIPS. FIPS approved algorithms currently include the Data Encryption Standard (DES) (FIPS 46-2) and the Escrow Encryption Standard (FIPS 185). Other related FIPS that are pointed to by FIPS 140-1 include Key Management using ANSI X9.17 (FIPS 171), the Secure Hash Standard (FIPS 180) and others. In addition, this standard specifies four security levels to provide for a wide spectrum of data sensitivity and a diversity of application environments. Each security level offers an increase in security over the preceding level. These four increasing levels of security will allow cost-effective solutions that are appropriate for different degrees of data sensitivity and different application environments. FIPS 140-1 is expected to be the foundation for NIST's current and future cryptographic standards.

6968 (CONF-9405111–, pp. Paper 8, 1-10) **Development history for procurement guidance using the trusted computer system evaluation criteria (TCSEC).** De Vilbiss, M.L. (Standards Criteria & Guidelines Division, Fort George G. Meade, MD (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

In this 10 year effort, through contracts with MITRE, through an NCSC working group, and now a National Security Agency (NSA) sponsored Procurement Guideline Working Group (PGWG), NSA has produced TCSEC Procurement Guidance, meeting the customer requirements, with Department of Defense (DoD) wide, as well as Federal Government wide, support.

6969 (CONF-9405111–, pp. Paper 9, 1-14) **Electronic resources for security related information.** Feingold, R. (Lawrence Livermore National Lab., CA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. DOE Contract W-7405-ENG-48. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The quantity, quality, and availability of electronic resources is multiplying rapidly. Information technology security professionals must make timely and effective use of these resources if they are to contain the growing threats of globally networked attackers. This paper outlines the threats including recent examples, and then provides multi-level descriptions of the abundant resources available to the information technology security community. These descriptions are valuable to everyone from a networking novice to a sophisticated expert. While the information is useful for the entire security community, this paper pays particular attention to Department of Energy requirements.

6970 (CONF-9405111–, pp. Paper 10, 1-18) **An intuitive exploration of current cryptography and recent developments and possibilities.** Feingold, R. (Lawrence Livermore National Lab., CA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. DOE Contract W-7405-ENG-48. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper is from the perspective of a computer security specialist. It emphasizes practical, contemporary cryptographic issues, and gives the reader an intuitive understanding of the topic. It is intended for management and technical people interested in computer and network security, and requires no special background or expertise. After discussing basic cryptography, the author explores recent developments such as the Federal Government's Clipper Chip (Skipjack) initiative and proposed Digital Signature Standard, and quantum cryptography. Our electronic society increasingly needs secure private communications. Current practical cryptographic technologies attempt to assure privacy by means of secret keys or one-way mathematical functions that even enormous expenditures of time and computational resources cannot invert. An attacker may compromise these methods through discovery of the secret keys, sophisticated as well as brute force cryptanalytic attacks, computationally feasible inversion of the mathematical functions, or by intercepting, altering, and then retransmitting the messages. Thus, most cryptographic applications suffer from the dilemma of either theoretical or practical limitations: 'Secret Key' systems endure the difficulties and risk of key exchange and storage, 'public key' systems lack theoretical proof of their soundness.

6971 (CONF-9405111–, pp. Paper 11, 1-6) **Challenges for DOE computer security order implementation into the 21st century.** Fulbright, J.D. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Challenges face people at every turn in life and Computer Security in the DOE nuclear weapons complex is no exception. The country has seen tremendous technological changes in how information is processed in the past 30 years, especially since the advent of the affordable personal computers in the 1980s. In fact, the computing power than used to be confined to a central computer room is now routinely provided in desktop, laptops, notebooks, and even palmtop computers. It comes as no surprises to any practicing security professional that they will face more and more challenges as the technologies emerge and they gravitate towards more distributive processing and transparent networking with the proposed information superhighways that one hears about so often. In this article, the author attempts to address the collective challenges for product evaluations, cost effectiveness, and professional certification and how one must position himself to prepare for the next century and it's projected technologies.

6972 (CONF-9405111–, pp. Paper 12, 1-12) **The Westinghouse Hanford Company Unclassified Computer Security Program.** Gurth, R.J. (Richland, WA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. DOE Contract AC06-87RL10930. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper describes the evolution of the Westinghouse Hanford Company (WHC) Unclassified Computer Security (UCS) Program over the past seven years. The intent has been to satisfy the requirements included in the DOE Order 1360.2B (DOE 1992) for Unclassified Computer Security in the most efficient and cost-effective manner.

6973 (CONF-9405111–, pp. Paper 13, 1-8) **Multilevel security guards: Controlling data flow.** Hahn, R. (Booz-Allen & Hamilton Inc., McLean, VA (United States)); Tretick, B. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy*

Computer Security Group Training Conference: Proceedings. 263p. Source: OSTI; NTIS.

Multilevel security (MLS) guards control the flow of information between two interconnected security boundaries processing data at different classification levels. They are often the initial step toward full MLS capability because they may be implemented in existing systems and can provide some of the interconnectivity required to bridge across the security boundaries of legacy systems.

6974 (CONF-9405111–, pp. Paper 14, 1-16) **A systems engineering approach to AIS accreditation.** Harris, L.M. (Los Alamos National Laboratory, NM (United States)); Hunteman, W.J. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The systems engineering model provides the vehicle for communication between the developer and the customer by presenting system facts and demonstrating the system in an organized form. The same model provides implementors with views of the system's function and capability. The authors contend that the process of obtaining accreditation for a classified Automated Information System (AIS) adheres to the typical systems engineering model. The accreditation process is modeled as a "roadmap" with the customer represented by the Designated Accrediting Authority. The "roadmap" model reduces the amount of accreditation knowledge required of an AIS developer and maximizes the effectiveness of participation in the accreditation process by making the understanding of accreditation a natural consequence of applying the model. This paper identifies ten "destinations" on the "road" to accreditation. The significance of each "destination" is explained, as are the potential consequence of its exclusion. The "roadmap" which has been applied to a range of information systems throughout the DOE community, establishes a paradigm for the certification and accreditation of classified AISs.

6975 (CONF-9405111–, pp. Paper 15, 1-8) **The network security plan – Uncharted waters.** Hawkins, R.G. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The requirement to produce a network security plan for a computer network has been in place for several years but the required elements of a network plan have only now been addressed in the new draft DOE Order 5639.6A. But the new order still does not address the complexity and magnitude of information needed to characterize networks the size of which reside in the DOE laboratories. Sandia is currently formulating the design of the second version of the network security plan for its Internal Secure Network (INS). This version follows the security plan format contained in the new draft order. But to produce a network plan that is manageable, it must be modularized. How network plans are modularized is the subject of this paper.

6976 (CONF-9405111–, pp. Paper 16, 1) **Beyond systems: Total Business continuity.** Hewitt, B. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

As information systems have grown to be integral parts of organizations, companies can ill afford to be "out of business", due to their unavailability. This session will explore the dynamic arena of business continuity beyond the traditional hot-site recovery, focusing on recovery strategies and planning, evolving technologies and how to maintain a sense of security in the face of unplanned interruption.

6977 (CONF-9405111–, pp. Paper 18, 1-10) **"Security and the quality system".** Huey, G.J. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The author looks at the issue of security from the perspective of a total quality management approach. It is necessary to decide what are the threats to a system, be they human, or non-human, malicious or accidental, and then weigh the importance vs cost of protecting against these threats. The presentation points out that often the issue of security is dealt with after the product is complete, but before management feels trust in releasing it, when there are severe time and cost constraints on addressing the perceived problems.

6978 (CONF-9405111–, pp. Paper 19, 1) **Computer security issues in the reconfiguration weapons complex.** Hunteman, W. (Los Alamos National Laboratory, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The Department of Energy (DOE) is developing design specifications for new facilities to replace the aging and obsolete nuclear weapons complex. These specifications are incorporating the latest safeguards, security, environment, safety, and health requirements. The DOE has directed that the design specifications include the latest proven, state-of-the-art technologies in all areas. The advanced technologies will reduce operational costs and minimize personnel exposure to hazardous materials while providing the maximum possible safeguards and security for the nuclear material and data processed or stored in each facility. The use of state-of-the-art automated information systems and networks for data processing, security management, material accounting and control, and material processing facilities will require careful planning and design to ensure the proper protection for all data and material. The computer security design principles being used to guide the design of the computer systems and networks are discussed. The data processing systems and networks planned for each of the new facilities will be discussed and the unique computer security issues identified. The nuclear material storage facilities will support inspections by third parties (either international and/or bilateral agreements). These inspections present a special requirement to share data with the inspection teams to allow their confirmation of the inventories while ensuring the teams do not gain unauthorized access to classified data.

6979 (CONF-9405111–, pp. Paper 20, 1) **DOE independent validation and verification program.** Hunteman, W. (Los Alamos National Laboratory, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer*

Security Group Training Conference: Proceedings. 263p. Source: OSTI; NTIS.

The Department of Energy has initiated an Independent Validation and Verification (IV&V) program for automated information systems that process classified data and have a protection index of two or greater. This paper describes the overall IV&V program, its goals and objectives, the methodologies used in an IV&V, and the products produced by an IV&V. The process for determining when an IV&V is needed, how to initiate and fund an IV&V, and the expected benefits of an IV&V are presented. The first IV&V performed under this program was conducted at Los Alamos National Laboratory and the lessons learned from this initial effort are described.

6980 (CONF-9405111–, pp. Paper 21, 1) **The proliferation information network system - a computer security case study.** Hunteman, W. (Los Alamos National Laboratory, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The treaties to reduce the superpowers nuclear arsenals have resulted in a dramatic decrease in nuclear weapons and a major initiative by the Department of Energy (DOE) to address the growing concerns about proliferation of nuclear and other weapons of mass destruction. This initiative is directed towards providing the organizations responsible for controlling the export of western technologies with the ability to detect when the sale of technology may contribute to the proliferation of mass destruction weapons. DOE is developing a network of distributed databases to support the analysis of technology issues relative to nonproliferation. The distributed network and databases will be described with the computer security issues involved in the assess and sharing of the classified and sensitive data. Future plans for the network include the connection of other US Government agencies which will create additional computer security requirements to ensure the proper protection and access controls for the data.

6981 (CONF-9405111–, pp. Paper 22, 1-20) **Management issues in automated audit analysis.** Jackson, K.A. (Los Alamos National Laboratory, NM (United States)); Hochberg, J.G.; Wilhelm, S.K.; McClary, J.F.; Christoph, G.G. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. DOE Contract W-7405-ENG-36. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper discusses management issues associated with the design and implementation of an automated audit analysis system that the authors use to detect security events. It gives the viewpoint of a team directly responsible for developing and managing such a system. They use Los Alamos National Laboratory's Network Anomaly Detection and Intrusion Reporter (NADIR) as a case in point. They examine issues encountered at Los Alamos, detail their solutions to them, and where appropriate suggest general solutions. After providing an introduction to NADIR, they explore four general management issues: cost-benefit questions, privacy considerations, legal issues, and system integrity. Their experiences are of general interest both to security professionals and to anyone who may wish to implement a similar system. While NADIR investigates security events, the methods used and the management issues are potentially applicable to a broad range of complex systems. These include those used to audit credit card transactions, medical care payments, and procurement systems.

6982 (CONF-9405111–, pp. Paper 23, 1-4) **Privacy issues for electronic mail.** Jennings, B. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Electronic mail has become an essential tool for conducting business and research in modern American corporations. Unfortunately, the use of this tool and other similar tools of electronic commerce has outstripped the ability to deal with privacy issues and corporate policies for E-mail use. Although the technology has been developed for privacy-enhanced E-mail, it is not yet in wide use. Similarly, even privacy enhanced technology does not provide total protection from a knowledgeable network manager. The increased use of electronic mail and other network technology has ignited concerns for privacy issues from a legal sense. The author will discuss a recent bill introduced to congress, the current Electronic Communication Privacy Act, and standard practice by employers in industry.

6983 (CONF-9405111–, pp. Paper 24, 1) **MVS system vulnerabilities: identification.** Jourde, Juan Carlos. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Does MVS security software provide effective protection for MVS systems? This session will provide a basic understanding of how system penetration can be accomplished from a general "nonprivileged" user. Many organizations rely upon the fact that they are audited, have an access control package, token ID cards, "proper" procedures and technical implementations, etc. Unfortunately those who target your systems do not care if certain controls are in place. These people will avoid controls and search for vulnerabilities in the implementation of the security envelope. Examples of major MVS security sensitive areas will be covered. The analysis includes MVS technical topics, "Social Engineering" threats, physical assess vulnerabilities, and other issues related to MVS systems security.

6984 (CONF-9405111–, pp. Paper 25, 1) **Private branch exchange (PBX) security guideline.** Kuhn, D.R. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Basic telephone switch system technology and security capabilities will be discussed. Threats and vulnerabilities of private branch exchange systems will be detailed based on the National Institute of Standards and Technology studies. An example security policy and baseline security controls will be presented along with a security assessment checklist.

6985 (CONF-9405111–, pp. Paper 26, 1) **Threat IV.** LaBarre, V. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The Director of Central intelligence is revising the "Threat to Automated Information Systems and Networks" document, otherwise

known as Threat III. While the new document, Threat IV, will concentrate on threats, it will discuss known vulnerabilities and incidents. Threat IV will also show the application of the threat-evaluation methodology developed in Threat III to several real-world problem areas. Threat IV is in the final review stage and is expected to be Promulgated by mid-1994, This presentation will give an overview of the contents of Threat IV and will discuss the application of the document's conclusions to the DOE community.

6986 (CONF-9405111–, pp. Paper 27, 1-10) **An overview of the Secure Network Server.** Leaman, J.R. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper will provide an overview of the Secure Network Server (SNS) program. It will discuss the history of SNS, the current state of this program, and the future direction and application of this technology. In the short term, SNS will provide the capability to securely interconnect networks of differing classification levels. In the future, the SNS will act as a secure Network File System (NFS) file server providing secure storage and separation for information with different classifications. This paper also describes the current SNS protocol suite as well as the migration to other communication protocols in support of future technological advances.

6987 (CONF-9405111–, pp. Paper 28, 1-6) **The DOE training resources and data exchange (TRADE) – a network of sharing.** Manning, D. (Oak Ridge Institute for Science and Education, TN (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The Training Resources and Data Exchange (TRADE) is a network that encourages and facilitates the exchange of ideas, techniques, and materials; and serves as a forum for the discussion of issues of interest to the DOE community. TRADE was established in 1978 when one DOE sponsor and 200 persons joined forces to create a network for improving training and development across DOE. Today there are 10 DOE sponsors and more than 5000 TRADE members located at most of the DOE sites and offices. The Oak Ridge Institute for Training and Development (ORISE), managed by the Oak Ridge Associated Universities, operates the TRADE network for the Department of Energy. An Executive Committee plans general TRADE activities and DOE advisors represent the program offices which support TRADE. All management and administrative activities are performed by ORISE staff.

6988 (CONF-9405111–, pp. Paper 29, 1) **Security information and resources on the Internet.** Mayson, W.; Cochrane, A. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This session will present a short overview of some of the public domain security and utility software available on the Internet. Information about the type of software available, locations to start looking for the software, and tools to aid in the search for this software will be presented. Also, an overview of books that provide more information will be presented. These books include those available from a bookstore as well as books available on the Internet itself. Software to be discussed is available for VMS, Unix, Macintosh, PC compatibles, and other platforms.

6989 (CONF-9405111–, pp. Paper 30, 1-6) **Applications of an NSA-Endorsed Type 1, data storage encryptor.** Meyers, R.V. (HRB Systems, State College, PA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Encryption is a well known and respected means of protecting all types of data in a variety of environments. Data storage is a new application of totally secure encryption. In this type of application any data that may be represented digitally may be encrypted and stored on any commonly available medium such as CD-ROM, tape, or disk. The SSP3110 Data Storage Encryptor is endorsed by the National Security Agency (NSA) at a "Type 1" device. This designation certifies it for use by the U.S. Government, and its appropriately cleared contractors, with any level of classified data. Once the data has been encrypted and recorded on the target medium, that medium may now be stored, shipped, and handled as UNCLASSIFIED. After a very brief explanation of the development and operation of the device, the author presents some examples of how users are taking advantage of these benefits.

6990 (CONF-9405111–, pp. Paper 31, 1) **Your role in interviews, interrogations, and investigations.** Mick, S. (Lawrence Livermore National Laboratory, CA (United States)); Robinson, G. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

As a computer security professional, you may be called on to assist site security or law enforcement personnel in the investigation of incidents, infractions, malicious activity or crimes involving DOE computer systems. This may involve interviewing or interrogating victims, witnesses, and suspects. You may also be required to conduct an investigation to locate evidence of misconduct or criminal activity in computer systems. This paper reviews the type of information you will want to request or search for in interviews or investigations.

6991 (CONF-9405111–, pp. Paper 32, 1-4) **Classified computer configuration control system (C^4S) revision 3.** O'Callaghan, P.B.; Nelson, R.A.; Grambihler, A.J. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The U.S. Department of Energy (DOE) computer security program in the past, present, and future has and will require computer security managers to keep detailed records of hardware and software used in classified processing. The information is constantly changing and must be updated. The information also needs to be easily accessible. Much of the information is similar in nature with variations in detail. All of these qualities led to the conclusion that the information needed to support management of classified computers is best stored in a computer database system. At the Hanford Site such a system has been in varying degrees of use and development since 1985. The C^4S had its beginning when it

started as a dBase III Plus system that was created by the Westinghouse Hanford Company (WHC) "Classified Automated Information System (AIS) Security Manager" to track classified computers being operated by WHC. Other contractors at the Hanford Site wanted to use it to aid in the administration of their systems. As such, an effort was begun to develop a more universal system. Revision 2 resulted in a more complex database and an application that worked with mouse control. Though Revision 2 was an improvement, the users wanted a database system that was more accessible with standard database management systems to do ad hoc information assessment and reporting. Efforts were then turned to developing Revision 3 that would have all the qualities of the previous developments but use Borland PARADOX tables.

6992 (CONF-9405111–, pp. Paper 33, 1-4) **NID - The network intrusion detector.** Palasek, R. (Lawrence Livermore National Laboratory, CA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The Network Intrusion Detector, NID, is a package of software tools whose signature detection component has been found to be effective in recognizing network based intrusions. It is used most often in retrospective mode, but it can and has been used in near real time or on-line mode. Different components perform traffic capture, filtering, examination and signature detection, reporting, and detailed analysis.

6993 (CONF-9405111–, pp. Paper 34, 1-14) **Issues in migrating from single-level to multi-level secure (MLS) databases.** Payne, P.W. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The move from single-level to multi-level secure (MLS) databases presents new issues in database design and implementation, some of which are not trivial. This paper addresses problems and options in moving from single-level to multi-level secure databases. Some of the issues discussed are; level of classification; polyinstantiation and cover stories; data integrity versus data security; aggregation; auditing; options for implementation of MLS Relational Data Base Management System (RDBMS) software; impacts on applications; and migration. In discussing options for MLS database design and implementation, three commercial MLS RDBMS products are considered: Oracle, Sybase, and Informix.

6994 (CONF-9405111–, pp. Paper 35, 1-6) **Security's role in technology transfer.** Pearson, L.A. (Lawrence Livermore National Lab., CA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

In April 1992, the Safeguards and Security Department Manager recognized that the Lawrence Livermore National Laboratory (LLNL) extended mission of collaborating with private industry would bring extended responsibilities to employees. LLNL employees understood their responsibilities for protecting classified and sensitive unclassified information, but protecting private industry's proprietary information was something different. With this issue in mind, the Department Manager assigned the Information and Security Awareness Group with the task of developing a Security Awareness Program that would inform and educate LLNL personnel on safeguarding proprietary/business protected information. The initial response to the program has been positive. LLNL employees are enthusiastic and eager for established guidelines. LLNL is the first laboratory to development a formal education program involving safeguarding proprietary information and several other DOE contractors have requested information and copies of their procedures. Potential partners have asked for copies of the procedures, expressing an interest in how LLNL will protect their proprietary information - confirming the importance of developing guidelines and procedures.

6995 (CONF-9405111–, pp. Paper 36, 1) **Secure, high-speed ATM networking for consolidation of Sandia's supercomputing site.** Pierson, L. (Sandia National Laboratories, Albuquerque, NM (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Sandia National Laboratories consolidated its secure supercomputing centers in California and New Mexico into a single site in New Mexico, while providing acceptable remote supercomputing service to researchers at Livermore. The initial multi-data-level security requirements and the Wide Area Network (WAN) performance requirements which must be satisfied to continue to provide acceptable remote supercomputing service were established early in this supercomputer consolidation project. An SMDS/ATM/DS3 intersite communication design as implemented to satisfy these requirements. This design incorporates the use of Broadband Integrated Services Data Network (BISDN) technology. The design utilizes Switched Multi-megabit Data Service (SMDS) access to Asynchronous Transfer Mode (ATM) Switchgear, and DS3 (45 Mb/s) encrypted intersite trunks. These DS3 links will later be replaced with Synchronous Optical Network (SONET) links. This communication design, intended to achieve secure, low delay, low error rate, high throughput, high availability Wide Area Networking for remote supercomputing and remote visualization of supercomputer output, has been evaluated in an extensive testbed. Initial testing has shown that this design achieves its performance and security goals and will be extensible to achieve the higher performance required over time. This paper will present an overview of how this ATM communication design satisfies both the performance requirements and the mandatory and discretionary controls required to process multiple data classification levels within a Q-cleared community of users.

6996 (CONF-9405111–, pp. Paper 37, 1-6) **Using trusted databases for unclassified purposes.** Rome, J.A. (Oak Ridge National Lab., TN (United States)); Baylor, L.R.; Payne, P.W. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The advantages of using secure databases on workstations with secure operating systems are discussed. An international fusion energy database is being used as a test bed for these ideas. Among the problems to be solved are connections across Internet at different security levels, and user-friendliness.

6997 (CONF-9405111–, pp. Paper 38, 1-7) **What do people really need to know about computer security incidents?.** Schultz, E.E. (Arca Systems, Inc., San Jose, CA (United States)); Christensen, M.; Ferro, P.H.; Jennings, T.E.; Teal, D.M. USDOE Assistant Secretary for Human Resources and Administration,

Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

What do people who respond to computer security incidents really need to know about the incidents they investigate? Although different agencies have different formal requirements for incident reporting, certain information may be essential for determining the technical and procedural aspects of incident response. The authors conducted a study to obtain an empirical answer to the issue in question. Personnel with experience on computer emergency response teams (CERTs) were interviewed as part of a study designed to obtain answers to this issue. Personnel were asked what information they need when an intrusion (either remotely or locally) occurs. Analysis indicates that there are seven major categories of required data about intrusions. Many of these categories include many specific information details (described in the paper); some details (e.g., the time the attack was first noticed) could be subsumed by more than one category. In general, interviewed personnel reported that they would rather have too much information rather than too little, and that ability to quickly assess a particular subset of the data was especially critical. Results suggest ways to increase the efficiency of incident responding and incident reporting.

6998 (CONF-9405111–, pp. Paper 39, 1) **Status report on CIAC.** Sparks, S. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Computer Incident Advisory Capability (CIAC) activities since the last conference will be discussed, including information on the following: (1) today's incident profile; (2) where most of today's threats have come from; (3) new threats on the horizon; (4) new hacking tools and techniques; (5) available tools and resources; (6) CIAC's electronic communications mechanisms; (7) CIAC and other incident response teams; (8) other services such as workshops, white-hat audits, etc.

6999 (CONF-9405111–, pp. Paper 40, 1-22) **Product considerations in secure development: Lessons learned from the development of trusted Solaris.** Sullivan, G. (Sun Microsystems Federal, Inc., Mountain View, CA (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The development process for Sun Microsystems' Solaris® CMW 1.0 operating system (now called Trusted Solaris®) has yielded some very valuable lessons learned about how to turn a trusted development into a commercially-available product. This paper will focus on the lessons about product issues that were learned during the development of Solaris (CMW) (Compartmented Mode Workstation). Special consideration will be given to networking and interoperability, maintaining the Sun Look and Feel, applications support, product support and training, and version maintenance of the trusted operating system so that it supports currently shipping hardware and software.

7000 (CONF-9405111–, pp. Paper 41, 1-4) **Business continuity planning.** Taylor, B. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Texas Instruments (TI) is a global manufacturing corporation with 41 manufacturing sites in 18 countries. Manufacturing operations, distribution center operations, and sales and marketing business functions are carried out globally. An extensive worldwide computer and communications network are in place to support this global business. Communications circuits ranging from 9.6 kbps to TI links are required to provide high bandwidth integrate voice and data communications. This global communication network is managed at a command center in Plano, Texas. By 1987, TI deployed 36 mainframe computer centers. These were located at most major business locations. Through constant review and evaluation of TI's information services, a better and more cost effective means for providing computer systems support was undertaken in 1989. A global computer center consolidation effort was implemented. This effort would, in five years, result in the consolidation of 36 computer centers into 3. The total savings to TI was $23 million dollars per year. Upon approval of the computer center consolidation program, the establishment of a viable disaster recovery capability was also directed. A five-year business recovery services contract was signed with IBM in May 1991. Computer center service availability, from the business functions point of view, became very important. Every hour of every day became prime time for one's computer systems. An acknowledged benefit from the total consolidation program was that performance levels increased even though more and more processing was being accomplished on fewer processors.

7001 (CONF-9405111–, pp. Paper 42, 1-6) **Privacy enhanced mail (PEM) experiences with CMW and MLS systems.** Tolliver, J.S. (Oak Ridge National Laboratory, TN (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Most current CMW and MLS systems provide a multilevel secure mail tool. The tools provided generally use SMTP for mail over TCP/IP and some sort of local mail transport for mail to other users on the local system. While the local mailer and SMTP mail can be multilevel secure (i.e., with MAC labels preserved), the tools do not provide the privacy enhancements of integrity or confidentiality of the received message, nor do they provide for non-repudiation by the sender. For local mail, the TCB generally provides confidentiality and perhaps non-repudiation, but does not explicitly address integrity in the sense of digital signatures. Some vendors claim to have hooks in their mail software to implement privacy enhancements once some privacy enhancement scheme becomes standard, but none has yet integrated privacy enhancements with MLS functionality. Within the single-level or non-trusted arena, the Privacy Enhanced Mail protocol (PEM) provides integrity, confidentiality, and non-repudiation services over SMTP networks, but does not address MLS issues. As a first step in attempting to understand the issues involved in combining privacy enhancements and MLS functionality, the author explores using Trusted Information Systems' TIS/PEM on CMW and MLS platforms. Since the hooks in the vendor's mail tool user agents are not available, he is forced to use some other user agent. The TIS/PEM package conveniently includes a modified MH (Rand Mail Handler) package that integrates PEM into the standard MH suite of tools.

7002 (CONF-9405111–, pp. Paper 43, 1-6) **Enhancing the Trust Technology Assessment Program (TTAP).** Toth, P.; Fiahavin, E. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC

(United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper provides a history and an amendment to the proposed program for the evaluation of trusted information technology products. A great deal of research is needed in this area to determine if reliance on the development process is an adequate means of gaining assurance. NIST and NSA are committed to exploring this new area of assurance and continuing to develop the Trust Technology Assessment Program. NIST and NSA are dedicated to increasing the number of security products available to the civil and private sectors.

7003 (CONF-9405111–, pp. Paper 44, 1-4) **New developments in national and international security criteria.** Troy, E.F. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This presentation will provide current information on the progress of U.S. and international work to achieve a "Common Information Technology Security Criteria" (CC). The CC Project is intended to replace the Information Technology (IT) security criteria in North America and the European Union with a single criteria for the development and evaluation of secure IT products and systems. The older criteria to be superseded include the U.S. Trusted Computer System Evaluation Criteria (the "Orange Book") and its successor, the draft Federal Criteria for IT Security (FC), along with the Canadian Trusted Computer Product Evaluation Criteria (CTCPEC), the European Information Technology Security Evaluation Criteria (ITSEC), and the draft International Standards Organization (ISO) security criteria. In June 1993, the governments of North America and the Commission for the European Communities (CEC) announced that they agreed to form a joint project to develop the CC in lieu of furthering any work on regional or national criteria. Participants include the European Union (EU, formerly the European Community), Canada, and the United States.

7004 (CONF-9405111–, pp. Paper 45, 1) **The changing nature of computer security threats.** Van Lehn, A. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper is on recent trends in computer security threats, based on the experiences of the U.S. Department of Energy's incident response team: CIAC. The conference presentation will report the very latest information for those whose job responsibility includes incident handling, computer security training and awareness, or who share an interest because they are users of computers and networked systems. Security personnel are seeing an increase in problems partly because the use of computers is increasing, but mostly because networking to world-wide electronic resources is rapidly increasing. Other factors involve present economic, political, and social conditions. Noted also is a non-trend-a trend which is needed but doesn't seem to be happening. Department of Energy sites are encountering an alarming increase in the number of new viruses. The trend is toward more sophistication and maliciousness (e.g., polymorphism, stealth, data scrambling, and disk drive burnout). The industry has seen the Virus Creation Laboratory (VCL) which makes the production of a new virus a simple menu selection process. Virus writers appear to be waging guerrilla warfare against those that "have the latest and best" computers. They see this new form of electronic sabotage as a way of leveling the computational playing field to overcome their perceived economic disadvantage.

7005 (CONF-9405111–, pp. Paper 46, 1) **The security evaluations approach to computer security: An update.** Wade, J.R. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

The DOE Deputy Assistant Secretary for Security Evaluations (EH-4) has been assigned the responsibility for establishing and implementing an independent inspection and assessment program to determine the effectiveness of DOE's safeguards and security policies and procedures, including their implementation. Computer security, for both classified and unclassified computer systems and networks, is one topic included in the Security Evaluations (SE) program. This presentation will provide an update of SE's approach to computer security, including inspection methodology, performance testing, and lessons learned.

7006 (CONF-9405111–, pp. Paper 47, 1-4) **How effective is your computer security awareness training?.** Walsh, T. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Because computer security training is mandatory, employee attitude affects what they will get out of the training. To ensure students are getting the most out of your training, you have got to gather quality measurements on the effectiveness of your program. What are some ways to measuring the effectiveness of the training? Four ways to measure the effectiveness of training are: (1) critiques, (2) skills check, (3) application of the training information, and (4) measurable results.

7007 (CONF-9405111–, pp. Paper 49, 1-8) **Security penetration approach.** Weiss, H. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

In order to perform a security penetration analysis of a system, several steps must be carried out by a small team of experts to ensure that the analysis will be carried out in a precise and forthright manner. This paper provides a high-level glimpse at an approach to performing a security penetration analysis.

7008 (CONF-9405111–, pp. Paper 50, 1) **Usefulness of a network reference monitor.** Williams, T. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This paper will discuss the usefulness of a datagram level network reference monitor (NRM) that supports Mandatory Access

Controls (MAC), Discretionary Access Control (DAC), Identification and Authentication (I&A), and Audit. It is based on the GKI VSLAN which is a B2 level network component that enforces a security policy at the data link layer of the OS1 protocol tack. Example architectures using non-evaluated and a variety of evaluated hosts shall be shown, and a discussion of the usefulness of the NRM in the architectures will be provided.

7009 (CONF-9405111–, pp. Paper 51, 1-12) **Multilevel information system security initiative.** Woodie, P. (Information Systems Security Organization, Meade, MD (United States)). USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Communications managers today face the conflicting pressures of increased network communications requirements and yet reduced communications budgets, while maintaining or increasing security in their networks. This is leading to the increased use of public networks, where network managers have little or no control over the security of these common-access network backbones. In addition, there is a long term goal to extend security back to the actual end users. These two factors lead to a concept called "writer-to-reader" security. In this approach to security, an e-mail message, for example, is protected from the time of origination at the end user's terminal ("writer"), where security services are applied, until the time of reading at the recipient terminal ("reader"). This is the fundamental percept of the Multi-level Information System Security Initiative (MISSI). This paper explains some of the motivations for this approach to security and how it is implemented in a family of compatible network security products. Included is an explanation of each component, and how it interacts with the other products to provide a balanced and graded approach to distributed network security. The paper then describes how these products will be combined into a series of phased releases that will provide both increasing security functionality and security assurance/trust.

7010 (CONF-9405111–, pp. Paper 1, 1) **Steve Jackson Games, communications, privacy, and auditing.** Bailey, D.; Smith, F.; Snyder, J. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

This talk will discuss enforcement of computer crime laws, the Electronic Communications Privacy Act (ECPA), and auditing using the Steve Jackson Games case as a vehicle. Steve Jackson Games of Austin, TX was the subject of a computer seizure in a complex case involving the theft of an electronic document from Bell South of Atlantic, GA. The computers were seized and held for over 2 years even though no one at Steve Jackson Games was ever accused of a crime, and no one one was ever charged. The self-destruction of the Government's case provides insights into the preparation of a case for prosecution (from the point-of-view of the victim), the content of the ECPA, and the privacy of electronic mail. The lessons from this case will also be applied to the problem of collecting and maintaining audit trails.

7011 (CONF-9405111–, pp. Paper 2, 1) **General IV&V operations.** Baker, L. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

An independent Verification and Validation (IV&V) exercise is intended to assist the Designated Accrediting Authority (DAA), the System Designers, and System implementors. The IV&V provides an unbiased outside view of the security design and implementation of a secure system (or network). The IV&V process assists the DAA by providing a technical view of the system from the policy and accreditation perspective. The IV&V process helps the System Designers and System implementors by providing an independent view from people who understand the technical and security aspects of the system.

7012 (CONF-9405111–, pp. Paper 17, 1) **Recovery strategies and planning.** Hewitt, B. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

As information systems have grown to be integral parts of present organizations, these organizations can ill afford to be "out of business", due to their unavailability. This session will explore the dynamic arena of business continuity beyond the traditional hot-site recovery, focusing on recovery strategies and planning, evolving technologies, and how to maintain a sense of security in the face of unplanned interruption.

7013 (CONF-9405111–, pp. Paper 48, 1-2) **Don't copy that floppy.** Wasch, K. USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Office of Information Resources Management Policy, Plans, and Oversight; USDOE Office of Intelligence and National Security, Washington, DC (United States). Office of Safeguards and Security. [1994]. From 16. Department of Energy computer security group training conference; Denver, CO (United States); 3-5 May 1994. In *16th Department of Energy Computer Security Group Training Conference: Proceedings.* 263p. Source: OSTI; NTIS.

Software piracy, the unauthorized duplication of copyrighted software, accounted for a 2.4 billion dollar loss to the software industry in 1990. Software piracy is not only a problem at the corporate level but in commercial businesses, educational, and non-profit institutions as well. Introduced are the three areas of SPA's Anti-Piracy activities: Litigation, Legislation, and Education. Examples of past law suits, audits, and other investigations are discussed; the legislation that provides a framework for their legal activities is referenced; and examples of public relations campaigns, aimed at informing the end-user of the consequences of software piracy are shared.

7014 (DOE/ER–0632) **ESnet Program Plan 1994.** Merola, S. USDOE Office of Energy Research, Washington, DC (United States). Office of Scientific Computing. 1 Nov 1994. 136p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95005329. Source: OSTI; NTIS; INIS; GPO Dep.

This Program Plan characterizes ESnet with respect to the current and future needs of Energy Research programs for network infrastructure, services, and development. In doing so, this document articulates the vision and recommendations of the ESnet Steering Committee regarding ESnet's development and its support of computer networking facilities and associated user services. To afford the reader a perspective from which to evaluate the ever-increasing utility of networking to the Energy Research community, we have also provided a historical overview of Energy Research networking. Networking has become an integral part of the work of DOE principal investigators, and this document is intended to assist the Office of Scientific Computing in ESnet program planning and management, including prioritization and funding. In particular, we identify the new directions that ESnet's development and implementation will take over the course of the next several years. Our basic goal is to ensure that the networking requirements of the respective scientific programs within Energy Research are addressed

fairly. The proliferation of regional networks and additional network-related initiatives by other Federal agencies is changing the process by which we plan our own efforts to serve the DOE community. ESnet provides the Energy Research community with access to many other peer-level networks and to a multitude of other interconnected network facilities. ESnet's connectivity and relationship to these other networks and facilities are also described in this document. Major Office of Energy Research programs are managed and coordinated by the Office of Basic Energy Sciences, the Office of High Energy and Nuclear Physics, the Office of Magnetic Fusion Energy, the Office of Scientific Computing, and the Office of Health and Environmental Research. Summaries of these programs are presented, along with their functional and technical requirements for wide-area networking.

7015 (ESTSC–000138CY00101) **DYNA3D. Explicit 3-d Hydrodynamic FEM Program.** Whirley, R.G. (Lawrence Livermore National Lab., CA (United States)); Englemann, B.E. Lawrence Livermore National Lab., CA (United States). 30 Nov 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Source: ESTSC.

Description: CRAY1; UNIX; FORTRAN; 1 QIC Cartridge. Compiles on both the Cray1 and Cray X-MP computers.

DYNA3D is an explicit, three-dimensional, finite element program for analyzing the large deformation dynamic response of inelastic solids and structures. DYNA3D contains 30 material models and 10 equations of state (EOS) to cover a wide range of material behavior. The material models implemented are: elastic, orthotropic elastic, kinematic/isotropic plasticity, thermoelastoplastic, soil and crushable foam, linear viscoelastic, Blatz-Ko rubber, high explosive burn, hydrodynamic without deviatoric stresses, elastoplastic hydrodynamic, temperature-dependent elastoplastic, isotropic elastoplastic, isotropic elastoplastic with failure, soil and crushable foam with failure, Johnson/Cook plasticity model, pseudo TENSOR geological model, elastoplastic with fracture, power law isotropic plasticity, strain rate dependent plasticity, rigid, thermal orthotropic, composite damage model, thermal orthotropic with 12 curves, piecewise linear isotropic plasticity, inviscid two invariant geologic cap, orthotropic crushable model, Moonsy-Rivlin rubber, resultant plasticity, closed form update shell plasticity, and Frazer-Nash rubber model. The hydrodynamic material models determine only the deviatoric stresses. Pressure is determined by one of 10 equations of state including linear polynomial, JWL high explosive, Sack Tuesday high explosive, Gruneisen, ratio of polynomials, linear polynomial with energy deposition, ignition and growth of reaction in HE, tabulated compaction, tabulated, and TENSOR pore collapse. DYNA3D generates three binary output databases. One contains information for complete states at infrequent intervals; 50 to 100 states is typical. The second contains information for a subset of nodes and elements at frequent intervals; 1,000 to 10,000 states is typical. The last contains interface data for contact surfaces.

7016 (ESTSC–000142IBMPC04) **RESRAD5.43. Site-Specific Residual Radioactivity.** Yu, C. (Argonne National Lab., IL (United States)). Lawrence Livermore National Lab., CA (United States). 1 Sep 1992. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: IBM PC; MS-DOS 3.1; Lahey F77L 3.01 (78%) and Microsoft QuickBASIC 4.5 (22%); 1 3.5 Diskette. Package does not have Source Code.

RESRAD5.43 is a computer code developed at Argonne National Laboratory (ANL) for the U.S. Department of Energy (DOE) to calculate site-specific residual radiation material guidelines and radiation dose/risk to an on-site individual (worker or resident) at a radioactively contaminated site. The RESRAD code has been adopted by the DOE in Order 5400.5 for the derivation of soil cleanup criteria and dose calculations, and it has been used widely by DOE, other federal agencies, and their contractors. The original models used by ANL to develop RESRAD were initially developed as part of a DOE effort that began in the early 1980s and involved most of the national laboratories and DOE program offices. The RESRAD code is continuously improved and updated to incorporate comments from users and new features that ease the interaction with users and increase the code's capability and flexibility. The DOE Offices of Environmental Guidance and Environmental Restoration also provide periodic guidance regarding any significant changes to the code.

7017 (ESTSC–000219I600001) **TOUGH2. Unsaturated Groundwater and Heat Transport Model.** Pruess, K. (Lawrence Berkeley National Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). 1 Jul 1991. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Source: ESTSC.

Description: IBM RS 6000; Operating System-Independent (Re-FORTRAN 77; 1 3.5 Diskette. Source Code upgraded to make possible the efficient simulation of large three-dimensional problems on the scale of 10,00 grid blocks. The conjugate gradient module requires no additional user input, with the exception of one single parameter for choosing which of the different solvers will be used.

TOUGH2 is a new and improved version of TOUGH. TOUGH2 offers added capabilities and user features, including the flexibility to handle different fluid mixtures (water, water with tracer; water, CO2; water, air; water, air, with vapor pressure lowering and water, hydrogen), facilities for processing of geometric data (computational grids), and an internal version control system to ensure referenceability of code applications. TOUGH2 is a multi-dimensional numerical model for simulating the coupled transport of water, vapor, air, and heat in porous and fractured media. The program provides options for specifying injection or withdrawal of heat and fluids. Although primarily designed for studies of high-level nuclear waste isolation in partially saturated geological media, it should also be useful for a wider range of problems in heat and moisture transfer, and in the drying of porous materials. For example, geothermal reservoir simulation problems can be handled simply by setting the air mass function equal to zero on input. The TOUGH2 simulator was developed for problems involving strongly heat-driven flow. To describe these phenomena a multi-phase approach to fluid and heat flow is used, which fully accounts for the movement of gaseous and liquid phases, their transport of latent and sensible heat, and phase transitions between liquid and vapor. TOUGH2 takes account of fluid flow in both liquid and gaseous phases occurring under pressure, viscous, and gravity forces according to Darcy's law. Interference between the phases is represented by means of relative permeability functions. The code handles binary, but not Knudsen, diffusion in the gas phase and capillary and phase adsorption effects for the liquid phase. Heat transport occurs by means of conduction with thermal conductivity dependent on water saturation, convection, and binary diffusion, which includes both sensible and latent heat.

7018 (ESTSC–000219MNFRM04) **TOUGH2. Unsaturated Groundwater and Heat Transport Model.** Pruess, K. (Lawrence Berkeley National Lab., CA (United States)). Lawrence Berkeley Lab., CA (United States). 1 Jul 1991. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. Source: ESTSC.

Description: MAINFRAMES; Operating System-Independent (Re-FORTRAN 77; 1 3.5 Diskette. Source Code upgraded to make possible the efficient simulation of large three-dimensional problems on the scale of 10,000 grid blocks. The conjugate gradient module requires no additional user input, with the exception of one single parameter for choosing which of the different solvers will be used.

TOUGH2 is a new and improved version of TOUGH. TOUGH2 offers added capabilities and user features, including the flexibility to handle different fluid mixtures (water, water with tracer; water, CO2; water,air; water, air, with vapor pressure lowering and water,hydrogen), facilities for processing of geometric data (computational grids), and an internal version control system to ensure referenceability of code applications. TOUGH2 is a multi-dimensional numerical model for simulating the coupled transport of water, vapor, air, and heat in porous and fractured media. The program provides options for specifying injection or withdrawal of heat and fluids. Although primarily designed for studies of high-level nuclear waste isolation in partially saturated geological media, it should also be useful for a wider range of problems in heat and moisture transfer, and in the drying of porous materials. For example, geothermal reservoir simulation problems can be handled simply by setting the air mass function equal to zero on input. The

TOUGH2 simulator was developed for problems involving strongly heat-driven flow. To describe these phenomena a multi-phase approach to fluid and heat flow is used, which fully accounts for the movement of gaseous and liquid phases, their transport of latent and sensible heat, and phase transitions between liquid and vapor. TOUGH2 takes account of fluid flow in both liquid and gaseous phases occurring under pressure, viscous, and gravity forces according to Darcy's law. Interference between the phases is represented by means of relative permeability functions. The code handles binary, but not Knudsen, diffusion in the gas phase and capillary and phase adsorption effects for the liquid phase. Heat transport occurs by means of conduction with thermal conductivity dependent on water saturation, convection, and binary diffusion, which includes both sensible and latent heat.

7019 (ESTSC–000228CY00100) **INGRID. 3-D Mesh Generation Nonlinear Systems.** Christon, M.A. (Lawrence Livermore National Lab., CA (United States)); Dovey, D.; Stillman, D.W.; Hallquist, J.O.; Rainsberger, R.B. Lawrence Livermore National Lab., CA (United States). 1 Sep 1992. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Source: ESTSC.

Description: CRAY1; UNIX; FORTRAN; 1 Cartridge.

INGRID is a general-purpose, three-dimensional mesh generator developed for use with finite element, nonlinear, structural dynamics codes. INGRID generates the large and complex input data files for DYNA3D, NIKE3D, FACET, and TOPAZ3D. One of the greatest advantages of INGRID is that virtually any shape can be described without resorting to wedge elements, tetrahedrons, triangular elements or highly distorted quadrilateral or hexahedral elements. Other capabilities available are in the areas of geometry and graphics. Exact surface equations and surface intersections considerably improve the ability to deal with accurate models, and a hidden line graphics algorithm is included which is efficient on the most complicated meshes. The primary new capability is associated with the boundary conditions, loads, and material properties required by nonlinear mechanics programs. Commands have been designed for each case to minimize user effort. This is particularly important since special processing is almost always required for each load or boundary condition.

7020 (ESTSC–000273CY00101) **TAURUS. 3-d Finite Element Code Postprocessor.** Whirley, R.G. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). 1 May 1991. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Source: ESTSC.

Description: CRAY1; UNIX; FORTRAN; 1 Mag Tape.

TAURUS reads the binary plot files generated by the LLNL three-dimensional finite element analysis codes, NIKE3D (ESTSC 139), DYNA3D (ESTSC 138), TACO3D (ESTSC 287), TOPAZ3D (ESTSC 231), and GEMINI (ESTSC 455) and plots contours, time histories,and deformed shapes. Contours of a large number of quantities may be plotted on meshes consisting of plate, shell, and solid type elements. TAURUS can compute a variety of strain measures, reaction forces along constrained boundaries, and momentum. TAURUS has three phases: initialization, geometry display with contouring, and time history processing.

7021 (ESTSC–000653I309000) **OMP. Occupational Medical Program.** Galloway, D. (Idaho National Engineering Lab., Idaho Falls, ID (United States)); Bode, M.; Batt, D.; Bills, R. Lockheed Idaho Technologies Co., Idaho Falls, ID (United States). 25 Oct 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC07-76ID01570. Source: ESTSC.

Description: IBM3090; MVS in a TSO/ISPF environment usI-CASE, COBOL II and C; 8 3.5 Diskettes. Proprietary software (Information Engineering Facility) is required to generate and maintain the software.

The Occupational Medical Program (OMP) oversees all Idaho National Engineering Laboratory (INEL) health care, and provides services to all managing and operating (M&O) contractors at the INEL and for the Department of Energy Idaho Office (DOE-ID). The evolution of the automated OMP at the INEL is guided by the U.S. Department of Energy (DOE) directives and regulations. The OMP is developing a multiyear plan for the computerization of patient and demographics, epidemiology, medical records, and surveillance. This plan will require the following six development phases: Employee Demographic Phase, Patient Surveillance Certification and Restrictions Phase, Electronic Notification Phase, Epidemiology-Industrial Hygiene/Radiation Exposure/OMP Integration Phase, Medical Scheduling Phase, and Medical Records Phase.

7022 (ESTSC–000704D0VAX00) **TRAMP. Transport of Metallic Fission Products Along Multiple Parallel Paths.** Hudritsch, W. (CEGA Corporation, San Diego, CA (United States)); Richards, M. General Atomics, San Diego, CA (United States). 1 Nov 1991. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-90CH10438. Source: ESTSC.

Description: DEC VAX; VMS; FORTRAN; 1 Mag Tape. Package compiled without error. Linkage failed undefined symbols (FORID, MERR, TICKER).

TRAMP is used to calculate the transport of metallic fission products along multiple parallel paths; the primary application is transport in and release from nuclear-grade graphite. The transport mechanisms are concentration-driven diffusion, thermal diffusion, and convection.

7023 (ESTSC–000713IBMPC00) **SAMPSIZE/TIDSIZE. Computes Sample Sizes Based on the Hypergeometric Distribution.** Bieber, A.M. Jr (Brookhaven National Lab., Upton, NY (United States)). Brookhaven National Lab., Upton, NY (United States). 1 Sep 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC02-76CH00016. Source: ESTSC.

Description: IBM PC; MS-DOS or PC-DOS version 3.1 or Microsoft C, version 7.0; 1 3.5 Diskette. If printed output is desired, it is directed to device PRN. If a serial printer is used, the DOS MODE command should be usedd to redirect printed output to the appropriate serial port.

SAMPSIZE computes the number of items required in a random sample without replacement from a population of known size in order to achieve 95% confidence that no more than 1% of the population possesses a given property (typically, some sort of defect). TIDSIZE performs the same computations for a 5% defect rate. The programs may be used to compute sample sizes necessary for performance testing of nuclear materials accounting and tamper-indicating device systems as specified in DOE office of Safeguards and Security Detection Element Evaluation Approaches.

7024 (ESTSC–000716IBMPC01) **NEAT1,2,3. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE regions 1,2 and 3 which include the following states: Connecticut (CT), Delaware (DE), Maine (ME), Maryland (MD), Massachusetts (MA), New Hampshire (NH), New Jersey (NJ), New York (NY), Pennsylvania (PA), Rhode Island (RI), Vermont (VT), Virginia (VA), Washington D.C. (DC), and West Virginia (WV).

The National Energy AudiT (NEAT) software package is the Department of Energy's (DOE) new energy auditing tool. NEAT is a program for personal computers that was designed for use by local agencies in the Weatherization Assistance Program. It is an approved alternative audit that meets all auditing requirements set forth by the program as well as those anticipated from new regulations pertaining to waiver of the 40 percent materials requirement.

7025 (ESTSC–000716IBMPC02) **NEAT4. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or

text editor and can be viewed in DOS. This version is for DOE Region 4 which includes the following states: Alabama (AL), Florida (FL), Georgia (GA), Kentucky (KY), Mississippi (MS), North Carolina (NC), South Carolina (SC), and Tennessee (TN).

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7026 (ESTSC–000716IBMPC03) **NEAT5. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE Region 5 which includes the following states: Illinois (IL), Indiana (IN), Michigan (MI), Minnesota (MN), Ohio (OH), and Wisconsin (WI).

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7027 (ESTSC–000716IBMPC04) **NEAT6. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE Region 6 which includes the following states: Arkansas (AR), Louisiana (LA), New Mexico (NM), Oklahoma (OK), and Texas.

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7028 (ESTSC–000716IBMPC05) **NEAT7. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE Region 7 which includes the following states: Iowa (IA), Kansas (KS), Missouri (MO), and Nebraska (NE).

The National Energy AudiT (NEAT) software package is the Department of Energy's (DOE) new energy auditing tool. NEAT is a program for personal computers that was designed for use by local agencies in the Weatherization Assistance Program. It is an approved alternative audit that meets all auditing requirements set forth by the program as well as those anticipated from new regulations pertaining to waiver of the 40 percent materials requirement.

7029 (ESTSC–000716IBMPC06) **NEAT8. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE region 8 which includes the following states: Colorado (CO), Idaho (ID), Montana (MT), North Dakota (ND), South Dakota (SD), Utah (UT), and Wyoming (WY).

The National Energy AudiT (NEAT) software package is the Department of Energy's (DOE) new energy auditing tool. NEAT is a program for personal computers that was designed for use by local agencies in the Weatherization Assistance Program. It is an approved alternative audit that meets all auditing requirements set forth by the program as well as those anticipated from new regulations pertaining to waiver of the 40 percent materials requirement.

7030 (ESTSC–000716IBMPC07) **NEAT9. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE Region 9 which includes the following states: Arizona (AZ), California (CA), Hawaii (HI), and Nevada (NV).

The National Energy AudiT (NEAT) software package is the Department of Energy's (DOE) new energy auditing tool. NEAT is a program for personal computers that was designed for use by local agencies in the Weatherization Assistance Program. It is an approved alternative audit that meets all auditing requirements set forth by the program as well as those anticipated from new regulations pertaining to waiver of the 40 percent materials requirement.

7031 (ESTSC–000716IBMPC08) **NEAT10. National Energy Audit.** Gettings, M. (Oak Ridge National Lab., TN (United STATES)). Oak Ridge National Lab., TN (United States). 1 Jul 1993. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; C; 1 3.5 Diskette. NEAT uses printer commands already existing on the computer to print results. No reconfiguration of the printer is necessary. Output files produced by the program are in a format readable by any word processor or text editor and can be viewed in DOS. This version is for DOE Region 10 which includes the following states: Alaska (AK), Oregon (OR), and Washington (WA).

The National Energy AudiT (NEAT) software package is the Department of Energy's (DOE) new energy auditing tool. NEAT is a program for personal computers that was designed for use by local agencies in the Weatherization Assistance Program. It is an approved alternative audit that meets all auditing requirements set forth by the program as well as those anticipated from new regulations pertaining to waiver of the 40 percent materials requirement.

7032 (ESTSC–000721SPARC00) **GPS. General Purpose Simulation.** Geyer, H. (Argonne National Lab, IL (United States)); Ewing, T.F. Argonne National Lab., IL (United States). 13 Jan 1991. Sponsored by Department of Defense, Washington, DC (United States). Source: ESTSC.

Description: SUN SPARC; Sun OS 4.x and OpenWindows 2.0; Sun C; 1 QIC Cartridge. The display graphics were developed in the XView 2.0 and NeWS 2.0 toolkits supplied with OpenWindows 2.0.

GPS is a general purpose simulation framework for system modeling and analysis. Arbitrarily complex systems of component models and interconnecting information flows can be handled. Although developed for the design and analysis of advanced energy system concepts, GPS handles continuous (static or dynamic) or discrete-event simulations. Systems can be assembled in a prototyping fashion from standard software components: component model libraries, property databases, and utility operators (plotters,

solvers, optimizers, etc.) under the control of an interpreted, object-oriented executive language. Systems can be arbitrarily complex in modeling sophistication, and new models can be added easily by the user. GPS also treats arbitrary system constraints over part or all of the system, including the specification of nonlinear objective functions to be minimized subject to equality or nonequality constraints.

7033 (ESTSC–000729IB48600) **SASIL. Sandia ATM SONET Interface Logic.** Kitta, J.P. (Sandia National Labs., Albuquerque, NM (United States)). Sandia National Labs., Albuquerque, NM (United States). 1 Jul 1994. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-76DP00789. Source: ESTSC.

Description: IBM PC 486; MS DOS 5.0 or higher with MicrosAHDL (30%), Altera Graphic Editor (60%), ABEL 5.0 (10%); 1 3.5 Diskette. The source code, which consists of AHDL and schematics generated by the Altera Graphic Editor must be compiled using Altera's MaxPlusII compiler version 4.02 or higher. Programming files created by Altera's MaxPlusII compiler are used to program the Altera EPLD's used to build the Sandia ATM SONET Interface. A programming interface card and a programming adapter, both made by Altera, are required to program Altera EPLD's using the programming files. The ABEL source code must be compiled using Data I/O's ABEL 5.0 compiler. A PAL programmer, made by Data I/O is needed to program the PAL22V10C's. Altera text design files (AHDL files) have a .tdf suffix, and Altera graphic design files (schematics) have a .gdf suffix. Altera also creates some files to represent lower design levels in hierarchial designs. The compiler ...

SASIL is used to program the EPLD's (Erasable Programmable Logic Devices) and PAL's (Programmable Array Logic) that make up a large percentage of the Sandia ATM SONET Interface (OC3 version) for the INTEL Paragon.

7034 (ESTSC–000737IBMPC00) **THCIF. Thermal Hydraulic Calculations for Single-Phase Flow of Incompressible Fluids.** Longest, A.W. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jan 1987. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS Version 2.0 or higher; LOTUS (TM) 1-2-3 (TM); 1 5.25 Diskette. THCIF operates as a single LOTUS (TM) 1-2-3 (TM) worksheet (or template). A User's guide for THCIF is available and should be consulted before using the software for real calculations.

The LOTUS(TM) 1-2-3(TM) based THCIF program is a convenient engineering tool for flow channel design and evaluation. It can be used to size flow channels to give desired flow rates and heat transfer characteristics, calculate flow rates and heat transfer coefficients for existing channels, calculate pressure drops across flow channel components (e.g., flow contraction, channel friction, flow expansion, and orifice), and calculate coolant temperature distributions for known heat input distributions. The program provides rapid calculations and, being enhanced by the many features of LOTUS(TM) it is easy to use, understand, and modify to suit the user's needs.

7035 (ESTSC–000743IBMPC00) **DDETS. Decontamination and Decommisioning Equipment Tracking System.** Cook, S.D. (EG and G Idaho, Inc., Idaho Falls, ID (United States)); Larsen, M.B.; Lively, G.A. EG and G Idaho, Inc., Idaho Falls, ID (United States). 13 Jul 1994. Sponsored by USDOE, Washington, DC (United States). Source: ESTSC.

Description: IBM PC; ORACLE and DOS; ORACLE (90%), C (10%); 4 3.5 Diskettes. DDETS cannot be executed without the Oracle RDBMS software properly loaded and configured on an IBM or compatible PC.

DDETS is Relational Data Base Management System (RDBMS) which incorporates 1-D (code 39) and 2-D (PDF417) bar codes into its equipment tracking capabilities. DDETS is compatible with the Reportable Excess Automated Property System (REAPS), and has add, edit, delete and query capabilities for tracking equipment being decontaminated and decommissioned. In addition, bar code technology is utilized in the inventory tracking and shipping of equipment.

7036 (ESTSC–000750IBMPC00) **ABSIM. Simulation of Absorption Systems in Flexible and Modular Form.** Grossman, G. (Israel Institute of Thechnology, Haifa, (Israel)). Oak Ridge National Lab., TN (United States). 1 Jun 1994. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Source: ESTSC.

Description: IBM PC; DOS; FORTRAN (70%) C (30%); 1 3.5 Diskette. Executables, data, and text files were supplied with the submitted media. Source and compilation instructions were not supplied with the submitted media. The executables seemed to run without error, but a sample set of input and/or output was not supplied.

The computer code has been developed for simulation of absorption systems at steady-state in a flexible and modular form, making it possible to investigate various cycle configurations with different working fluids. The code is based on unit subroutines containing the governing equations for the system's components. When all the equations have been established, a mathematical solver routine is employed to solve them simultaneously. Property subroutines contained in a separate data base serve to provide thermodynamic properties of the working fluids. The code is user-oriented and requires a relatively simple input containing the given operating conditions and the working fluid at each state point. the user conveys to the computer an image of the cycle by specifying the different components and their interconnections. Based on this information, the program calculates the temperature, flowrate, concentration, pressure and vapor fraction at each state point in the system and the heat duty at each unit, from which the coefficient of performance may be determined. A graphical user-interface is provided to facilitate interactive input and study of the output.

7037 (ESTSC–000751IBMPC00) **BEIDMS1.3. Bechtel Environmental Integrated Database Management System.** Forstrom, K. (Bechtel Environmental Inc., Oak Ridge, TN (United States)); Wallace, J.; Goodwin, D. National Research Council, Washington, DC (United States). Committee on National Urban Policy. 9 Sep 1994. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-91OR21949. Source: ESTSC.

Description: IBM PC; MS-DOS; SQL Forms v3.0 (80%), SQL Report Writer v1.1 (2%), SQLMenu v5.0 (5%), ProC v1.2 (10%), MS-DO7 3.5 Diskettes. In the BEIDMS1.3 source code, file extensions are as follows: .BAT MS-DOS command file, .DMM executable for an Oracle SQL*Menu program, .INP source code for an Oracle*Forms program, .FRM executable for an Oracle SQL*Forms program, .REX dump file for an Oracle SQL*ReportWriter program, .REP executable for an Oracle SQL*ReportWriter program, .SQL Oracle SQL*Plus report or script, .PC source code for an Oracle Pro*C program, .H header file for a C program, .C source code for a C program.

Bechtel Environmental Integrated Data Management System (BEIDMS1.3) is an Oracle based relational database that stores data related to all aspects of environmental data collection.

7038 (ESTSC–000752SPARC00) **CVODE. Stiff/Nonstiff Ordinary Differential Eqn Solver in C, Direct and Iterative Metho.** Cohen, S. (Lawrence Livermore National Lab., CA (United States)); Hindmarsh. Lawrence Livermore National Lab., CA (United States). 1 Sep 1994. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. Source: ESTSC.

Description: SUN SPARC; Unix; ANSI-C; 1 3.5 Diskette. The package supplied consists of a single archive file, cvode.tar. Installation from this file assumes a Unix system with the tar utility.

CVODE is a package written in ANSI standard C for solving initial value problems for ordinary differential equations. It solves both stiff and non stiff systems. In the stiff case, it includes a variety of options for treating the Jacobian of the system, including dense and band matrix solvers, and a preconditioned Krylov (iterative) solver.

7039 (ESTSC–000757D078000) **SISAL. Parallel Machine Data-Flow Language.** Skedzielewski, S.K. (Lawrence Livermore National Lab., CA (United States)). Lawrence Livermore National Lab., CA (United States). 1 Dec 1985. Sponsored by USDOE, Washington, DC (United States). (NESC–9707). Source: ESTSC.

Description: DEC VAX11/780; UNIX; PASCAL; 1 Mag Tape.

SISAL (Streams and Iteration in a Single-Assignment Language) is a functional data-flow language intended for use on a variety of

sequential, vector, multi, and data-flow processors. It is designed to express algorithms for execution on computers capable of highly concurrent operations. The application area supported is numerical computation which strains the limits of high performance machines. IF1 is a set of programs which take IF1 (Intermediate Format) files produced by the SISAL compiler and prepare them for execution on the LLNL debugger/interpreter, which can be used to debug and execute IF1 programs. The set of IF1 programs includes the debugger/interpreter, a prettyprinter for IF1 files, a common subexpression eliminator, an IF1 file structural checker, a loop invariant remover, a loop and test inverter, and programs to topologically sort IF1 files, expand functions inline, and count nodes in IF1 files.

7040 (ESTSC–000758C650000) **2DEPEP. Solves Partial Differential Equations Systems.** Sewell, E.G. (Purdue University, West Lafayette, IN (United States)). Oak Ridge National Lab., TN (United States). 1 Oct 1978. Sponsored by USDOE, Washington, DC (United States). (NESC–806). Source: ESTSC.

Description: CDC6500; SCOPE; FORTRAN IV; 1 Mag Tape. The program is written to process input data for one problem only per execution.

2DEPEP solves the partial differential equation system: C1(X,Y,U,V,T) *DU/DT=D(OXX)/DX+D(OXY)/DY+F1(X,Y,U,V,T) C2(X,Y,U,V,T) *DV/DT=D(OYX)/DX+D(OYY)/DY+F2(X,Y,U,V,T) in a general two-dimensional region, R, with U=FB1(S), V=FB2(S) for S on BR1, and OXX*NX+OXY*NY=GB1(S,U,V,T) OYX*NX+OYY*NY=GB2(S,U,V,T) for S on BR2, where BR1 and BR2 are distinct parts of the boundary. (NX,NY)= unit outward normal. U=UO(X,Y) V=VO(X,Y) for T=TO, and OXX=OXX(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T) OXY=OXY(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T) OYX=OYX(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T) OYY=OYY(X,Y,DU/DX,DU/DY,DV/DX,DV/DY,T). The Jacobian matrices of derivatives of OXX,OXY,OYX,OYY with respect to DU/DX,DU/DY,DV/DX,DV/DY and of F1,F2 with respect to U,V and of GB1,GB2 with respect to U,V must be symetric. The related ellipitic and eigenvalue problems are also solved by 2DEPEP and single equations can be handled efficiently. Examples of applications of the program are elasticity, one or two component diffusion, heat conduction, minimal surface, potential problems, and the time independent and time dependent Schrodinger equations.

7041 (ESTSC–000759IBMPC00) **CIRCUIT2.4. 2-Stage Classification Modeling.** Wilde, R.A. (DOE Idaho Operations Office, Idaho Falls, ID (United States)); Anderson, J.V. EG and G Idaho, Inc., Idaho Falls, ID (United States). 1 Dec 1987. Sponsored by USDOE, Washington, DC (United States). (NESC–9529). Source: ESTSC.

Description: IBM PC; MS-DOS 2.5 or later; Microsoft FORTRAN 3.3; 2 5.25 Diskettes.

CIRCUIT2.4 is used to design optimum two-stage classification configurations and operating conditions for energy conservation. It permits simulation of five basic grinding-classification circuits, including one single-stage and four two-stage classification arrangements. Hydrocyclones, spiral classifiers, and sieve band screens can be simulated, and the user may choose the combination of devices for the flowsheet simulation. In addition, the user may select from four classification modeling methods to achieve the goals of a simulation project using the most familiar concepts. Circuit performance is modeled based on classification parameters or equipment operating conditions. A modular approach was taken in designing the program, which allows future addition of other models with relatively minor changes.

7042 (ESTSC–000760IBMPC00) **ASENT. Analysis of Sensitivity Experiment Data.** Ashcraft, R.W. (Mason and Hanger Silas Mason Co., Inc., Pantex Plant, Amarillo, TX (United States)). Mason and Hanger-Silas Mason Co., Inc., Amarillo, TX (United States). 1 Dec 1987. Sponsored by USDOE, Washington, DC (United States). (NESC–1103). Source: ESTSC.

Description: IBM PC; DOS 3.3; Microsoft QuickBASIC 4.0; 1 5.25 Diskette. Output produced by ASENT can be sent to a disk file or a printer; the plotting routine is written for a high-resolution (CGA) graphics screen. The DOS GRAPHICS.COM is used to print the plots on Epson and IBM compatible printers; this program is not included.

ASENT is designed to provide analysis for several experimental designs, including Probit, Bruceton, and Langlie One-Shot. The program is used for analysis of data from skid, friction, gap, drop hammer, Henkin, and flyer sensitivity tests. ASENT determines the population mean and standard deviation along with their estimated variance and covariance from the stimulus levels used and the number of failures and successes at each level. The population percentiles are also given to any desired confidence level.

7043 (ESTSC–000761IBMPC00) **SOLAR5. Passive Energy Building Design Tool.** Milne, M. (University of California, Los Angeles, CA (United States)). Oak Ridge National Lab., TN (United States). 13 Mar 1984. Sponsored by USDOE, Washington, DC (United States). (NESC–9547). Source: ESTSC.

Description: IBM PC; PC-DOS; Ryan-McFarland FORTRAN; 5 5.25 Diskettes. SOLAR5 uses the FORTPAK/FORLIB PLUS graphic package to generate graphical output. Directives are included to overlay SOLAR5 with the Phoenix Software Associates' PLINK86-Plus linkage editor.

SOLAR5 is a computer aided design tool to help architects design better, more energy efficient buildings. It is intended for use at the beginning of the design process. To get started, only four pieces of information are necessary to compute the energy needed: the square footage, the number of stories, the kind of building (such as school, home, hotel, or any one of 20 types), and its location (the program stores the temperature ranges for fourty major cities). Additional information may be given later to fine tune the design. An expert system using heuristics from a wide range of sources, automatically creates a passive solar baseline building from the four facts specified for that project. By modifying and adapting prior designs the user can create and work upon as many as nine schemes simultaneously. SOLAR5 can analyze the buildings thermal performance for each hour of each month and plot its total heat gain or loss as a three-dimensional surface. After reading the plot, the user can immediately redesign the building and rerun the analysis. Separate heat gain/loss surfaces can be plotted for each of the different parts of the building or schemes that add together to make up the total, including walls, roof, windows, skylights, floor, slab on grade, people, lights, equipment, and infiltration. Two different schemes can be instantly compared by asking for a three-dimensional plot showing only the difference in their performances. The objective of SOLAR5 is to allow the designer to make changes easily and quickly with detailed instantaneous pictorial feedback of the implications of the change.

7044 (ESTSC–000762IBMPC00) **ZIP. Economic Insulation Levels for Houses.** McElroy, D. (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jan 1989. Sponsored by USDOE, Washington, DC (United States). (NESC–9496). Source: ESTSC.

Description: IBM PC; MS-DOS; Microsoft QuickBASIC 4.0; 1 5.25 Diskette.

ZIP was developed to support the calculations and database used to estimate the economic levels of insulation published in the U.S. Department of Energy's Insulation Fact Sheet. The program allows the user to estimate economic levels of insulation for attics, exterior walls, floors over unheated areas, slab floors, and basement and crawlspace walls for new and existing houses in any 3-digit zip code location in the U.S., based on local climate data, local prices for energy and insulation, and the type and estimated efficiency of its heating and cooling system. ZIP recognizes five different heating systems: natural gas, oil furnaces, electric furnaces, electric baseboard, and electric heat pump and two cooling systems: central and window electric air conditioners. An evaporative cooling system can also be specified, but this is not treated as a true air-conditioning system. In addition, the user can specify the approximate operating efficiency of the heating and cooling systems (low, medium, high, or very high). ZIP can be run for a single zip code and specified heating and cooling system or in a batch mode for any number of consecutive zip codes to provide a table of economic insulation levels for use at the state or national level.

7045 (ESTSC–000763I036000) **DENDRO. Hierarchial Cluster Analysis Code.** Larson, N.M. (Oak Ridge National Lab., TN (United States)); Begovich, C.L. Oak Ridge National Lab., TN

(United States). 1 Apr 1980. Sponsored by USDOE, Washington, DC (United States). (NESC–840). Source: ESTSC.

Description: IBM360; OS/360,370; FORTRAN; 1 Mag Tape. Plots are produced using the proprietary Integrated Software Systems Corporation DISSPLA software. The proprietary International Mathematical and Statistical Libraries (IMSL) routine, MDNRIS, for the inverse standard normal (Gaussian) probability distribution function is used, also.

DENDRO performs hierarchial cluster analysis of experimental data with options for data normalization, metrics, and clustering criteria. A dendogram, or tree plot, can be generated on a line printer or plotter illustrating which clusters are combined at what distance.

7046 (ESTSC–000765C660000) **BESSEL FUNCTIONS. Airy & log gamma subroutines.** Amos, D.E. (Sandia National Labs., Albuquerque, NM (United States)); Daniel, S.L. Sandia National Labs., Albuquerque, NM (United States). 2 Sep 1975. Sponsored by USDOE, Washington, DC (United States). (NESC–656). Source: ESTSC.

Description: CDC6600; SCOPE 3.3; FORTRAN IV; 1 Mag Tape. Diagnostic prints are handled from ERRCHK. For Jnu(x), Inu(x), K0(x), K1(x), a non-zero parameter NZ is returned for underflow with a zero value assigned the function.

Subroutines for evaluating Bessel functions: JO(x), J1(x), IO(x), I1(x) for x between + and - infinity; YO(x), Y1(x), KO(x), K1(x) for x greater than zero; Jnu(x), Inu(x) for x greater than or equal to 0 and nu greater than or equal to 0; Yn(x), Kn(x) for x greater than o and n=0,1,2..; Airy functions: Ai(x), Ai'(x), Bi(x), Bi'(x) for x between + and - infinity: and the log gamma function: LNGAMMA(x) for x greater than 0.

7047 (ESTSC–000769C760000) **LOTS. Los Alamos Optical Transport Simulator.** Barnard, C.C. (University of New Mexico, Albuquerque, NM (United States)); Lawrence, G.N.; Munroe, J.L.; Sklar, E. Los Alamos National Lab., NM (United States). 1 May 1983. Sponsored by USDOE, Washington, DC (United States). (NESC–9857). Source: ESTSC.

Description: CDC7600; LTSS; FORTRAN IV; 1 Mag Tape. Both LOTS1 and LOTS2 use routines from two LANL graphics libraries to produce graphical output; these routines are not included and will have to be replaced with suitable local alternatives.

LOTS is a very general code suitable for solving a wide variety of problems in numerical physical optics and beam propagation. It presently exists as two separate releases LOTS1 and LOTS2. The LOTS codes combine a Fast Fourier Transform propagator with a versatile and user friendly command language

7048 (ESTSC–000771IBMPC00) **COALEVAL. Mine-to-market Analysis Low Ash Coal.** Downey, K. (Pittsburgh Energy Technology Center, PA (United States)). USDOE Pittsburgh Energy Technology Center, PA (United States). 31 Mar 1987. Sponsored by USDOE, Washington, DC (United States). (NESC–9544). Source: ESTSC.

Description: IBM PC; DOS; Turbo Pascal; 1 5.25 Diskette. The source language is not available.

COALEVAL is a coal evaluation model (CEM) for assessing technical and economic aspects of producing low ash coals for use in the production of coal water mixtures. Through the use of this model, any coal for which quality and/or washability data exist can be incorporated into a reasonably elaborate mine-to-market coal use scenario. Process performance can be dictated by the user on the basis of specific gravity of separation, recovery of the raw coal heat content, or a specific coal quality parameter such as ash, sulfur, or heating value. Also considered is the option to incorporate pelletizing and/or coal water slurry production. To account for case specific conditions, the operator may separate the various process steps by any selected geographic distance; the model automatically takes into consideration the costs associated with different transportation modes. The model provides a convenient, yet powerful, desk-top tool capable of making rapid approximations of the cost of various coal preparation schemes along with more complex situations where multiple process steps are linked to produce a low-ash coal-based fuel such as coal water mixtures. Additionally, sensitivity analyses of hypothetical mine-to-market scenarios can be performed to focus on those elements where minor changes in efficiency and/or cost will have significant impacts on the delivered product cost. The output of the analysis is displayed on the terminal screen and can be printed in summary report form.

7049 (ESTSC–000772IBMPC00) **RNS. Research Notes and Information References.** Hartley, D.S. III (Oak Ridge National Lab., TN (United States)). Oak Ridge National Lab., TN (United States). 1 May 1988. Sponsored by Department of Defense, Washington, DC (United States). (NESC–9484). Source: ESTSC.

Description: IBM PC; DOS 3.xx; dBASE III Plus; 1 5.25 Diskette. The proprietary Ashton-Tate dBASE III Plus database management software is required; this software is not included.

The RNS (Research Notes System) is a set of programs and databases designed to aid the research worker in gathering, maintaining, and using notes taken from the literature. The sources for the notes can be books, journal articles, reports, private conversations, conference papers, audiovisuals, etc. The system ties the databases together in a relational structure, thus eliminating data redundancy while providing full access to all the information. The programs provide the means for access and data entry in a way that reduces the key-entry burden for the user. Each note has several data fields. Included are the text of the note, the subject classification (for retrieval), and the reference identification data. These data are divided into four databases: Document data - title, author, publisher, etc., fields to identify the article within the document; Note data - text and page of the note; Sublect data - subject categories to ensure uniform spelling for searches. Additionally, there are subsidiary files used by the system, including database index and temporary work files. The system provides multiple access routes to the notes, both structurally (access method) and topically (through cross-indexing). Output may be directed to a printer or saved as a file for input to word processing software.

7050 (ESTSC–000775IBMPC00) **DEEPWATER. Replacement Cost of Domestic Crude.** Reister, David B. (Oak Ridge National Lab.,TN (United States)). Oak Ridge National Lab., TN (United States). 1 Jun 1988. Sponsored by USDOE, Washington, DC (United States). (NESC–1141). Source: ESTSC.

Description: IBM PC; MS-DOS; FORTRAN; 2 5.25 Diskettes.

The DEEPWATER model forecasts the replacement cost of domestic crude oil for 13 offshore regions in the lower 48 states. The replacement cost of domestic crude oil is the constant or levelized selling price that will recover the full expense of exploration, development, and productions with a reasonable return on capital.

7051 (ESTSC–000776IB48600) **EMAF. Engineering Model for Ash Formation.** Wilemski, Dr. G. (PSI Technology Company, Andover, MA (United States)); Srinivasachar, Dr. S.; Helble, Dr. J.J. Physical Sciences, Inc., Andover, MA (United States). 4 Dec 1994. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC22-86PC90751. Source: ESTSC.

Description: IBM PC 486; DEC Microvax II (VMS version 5.3FORTRAN; 1 3.5 Diskette. The only action required by the user is to write the input file and run the code.

Ash deposition is controlled by the impaction and sticking of individual ash particles to heat transfer surfaces. Prediction of deposition therefore requires that the important factors in this process be predictable from coal and operational parameters. Coal combustion, boiler heat transfer, ash formation, ash particle aerodynamic, and ash particle sticking models are all essential steps in this process. The model described herein addresses the prediction of ash particle size and composition distributions based upon combustion conditions and coal parameters. Key features of the model include a mineral redistribution routine to invert CCSEM mineralogical data, and a mineral interaction routine that simulates the conversion of mineral matter into ash during coal burning and yields ash particle size and composition distributions.

7052 (ESTSC–000777I037000) **ADEPT. aerosol deposition in cylindrical pipes.** Fazekas, P. (Burns and Roe, Oradell, NJ (United States)); Tewarson, S.C. Burns and Roe Enterprises, Inc., Oradell, NJ (United States). 1 Jan 1985. Sponsored by USDOE, Washington, DC (United States). (NESC–9761). Source: ESTSC.

Description: IBM370; MVS; FORTRAN IV; 1 Mag Tape.

ADEPT calculates the deposition of aerosols in straight cylindrical pipes during turbulent air flow. Aerosol deposition is calculated in a time-dependent manner based on empirical correlations for

turbulent flow in pipes. The calculated deposition during a single time interval is cumulative with that of previous time intervals and results in a decreasing inner diameter of the pipe. The calculated deposition is assumed uniform over the length of the pipe. The entering aerosol distribution is specified by the user in the form of a log-normal distribution of accumulated mass versus particle size and may be time dependent. Entering flow conditions are also specified by the user and may also be time dependent. For simplicity and generality, the geometry implicit in the program is that of a cylindrical pipe with no bends or fittings. The flow is turbulent and monodirectional; only one set of inlet conditions may be applied at a given time. The flow parameters are not calculated along the length of pipe; therefore, the dynamic behavior of the aerosol within the pipe as well as the effects of reentrainment cannot be determined explicitly. A typical problem requires 2 minutes of CPU time.

7053 (ESTSC–000779D0VAX00) **MAG. Mag Tape Utility.** Thompson, Charles (Science Applications International Corp., Oak Ridge, TN (United States)); Newman, Gerald K. Los Alamos National Lab., NM (United States). 13 Jul 1986. Sponsored by US-DOE, Washington, DC (United States). Source: ESTSC.

Description: DEC VAX; VMS; MACRO (90%), MESSAGE (10%); 1 8mm Cassette.

MAG is a general-purpose tape utility program which runs on any Digital Equipment Corporation VAX computer system and can write and read fixed-block, fixed-record magnetic tapes. In addition, MAG can read tapes written using ANSI standard record format as well as the IBM Variable Blocked format. Translation from ASCII to EBCDIC and vice versa can be performed.

7054 (ESTSC/NRC/R–000719IBMPC00) **CEMENT1.02. Performance Cement Concrete Nuclear Barriers and Other Components.** Plansky, Dr. L.E. (EG and G Idaho Inc., Idaho Falls, ID (United States)); Seitz, R.R. EG and G Idaho, Inc., Idaho Falls, ID (United States). 13 Mar 1994. Sponsored by Nuclear Regulatory Commission, Washington, DC (United States). Office of Nuclear Regulatory Research. Source: ESTSC.

Description: IBM PC; DOS; FORTRAN 77; 1 3.5 Diskette.

CEMENT is a program that can be used to estimate various aspects of the long term performance of cement-based barriers used in low-level radioactive waste disposal facilities.

7055 (JAERI-M–94-019, pp. 380-386) **An index database of Charged-Particle Nuclear Reaction Data.** Chiba, Masaki (Sapporo Gakuin Univ., Ebetsu, Hokkaido (Japan).); Kato, Kiyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1994. (CONF-9311139–: 1993 symposium on nuclear data, Tokai (Japan), 18-19 Nov 1993; INDC(JPN)–169/L). In *Proceedings of the 1993 symposium on nuclear data.* 441p. Order Number DE94785276. Source: OSTI; NTIS; INIS.

We give a brief explanation of a retrieval system for the index information of Charged-Particle Nuclear Reaction Data, which has been installed in Hokkaido University Computing Center. For the installation of these data, the ORION Information Retrieval System has been used. The main purpose of the new system is to open a way for researchers to get benefits from utilizing the Charged-Particle Reaction Data in NRDF and EXFOR systems. (author).

7056 (LA-UR–94-2790) **Network Event Recording Device: An automated system for Network anomaly detection, and notification. Draft.** Simmons, D.G.; Wilkins, R. Los Alamos National Lab., NM (United States). [1994]. 28p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950233–1: Internet Society symposium, San Diego, CA (United States), 16-27 Feb 1995). Order Number DE94018274. Source: OSTI; NTIS; GPO Dep.

The goal of the Network Event Recording Device (NERD) is to provide a flexible autonomous system for network logging and notification when significant network anomalies occur. The NERD is also charged with increasing the efficiency and effectiveness of currently implemented network security procedures. While it has always been possible for network and security managers to review log files for evidence of network irregularities, the NERD provides real-time display of network activity, as well as constant monitoring and notification services for managers. Similarly, real-time display and notification of possible security breaches will provide improved effectiveness in combating resource infiltration from both inside and outside the immediate network environment.

7057 (LA-UR–94-3301) **A parallel, portable and versatile treecode.** Warren, M.S. (Los Alamos National Lab., NM (United States)); Salmon, J.K. Los Alamos National Lab., NM (United States). [1994]. 7p. Sponsored by National Aeronautics and Space Administration, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-950212–1: 7. SIAM conference on parallel processing for scientific computing, San Francisco, CA (United States), 15-17 Feb 1995). Order Number DE95000842. Source: OSTI; NTIS; GPO Dep.

Portability and versatility are important characteristics of a computer program which is meant to be generally useful. We describe how we have developed a parallel N-body treecode to meet these goals. A variety of applications to which the code can be applied are mentioned. Performance of the program is also measured on several machines. A 512 processor Intel Paragon can solve for the forces on 10 million gravitationally interacting particles to 0.5% rms accuracy in 28.6 seconds.

7058 (LBL–34780) **A tool for debugging Internet multicast routing.** Agarwal, D.; Floyd, S. Lawrence Berkeley Lab., CA (United States). Mar 1994. 8p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC03-76SF00098. (CONF-9403132–2: 1994 ACM symposium on applied computing, Phoenix, AZ (United States), 6-8 Mar 1994). Order Number DE95003433. Source: OSTI; NTIS; GPO Dep.

In this paper the authors describe a debugging tool that is an effective means of analyzing problems with multicast packet routing in a network. Multicast packet routing is a source-driven distributed calculation performed by the routers in a multicast network. The routes taken by multicast packets are difficult to predict manually due to the large number of variables that must be considered. The multicast route debugging tool allows off-line investigation of the route taken by a multicast packet and the effects of network modifications on that route. The tool has already proved useful in debugging the problems that have occurred in the experimental Internet Multicast Backbone. The multicast route debugging tool currently predicts multicast routes of packets using the distance-vector truncated-broadcast algorithm implemented for Internet multicast traffic. They will be upgrading the tool to allow the user to choose other multicast routing algorithms.

7059 (SAND–92-2137) **EXODUS II: A finite element data model.** Schoof, L.A.; Yarberry, V.R. Sandia National Labs., Albuquerque, NM (United States). Sep 1994. 239p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. Order Number DE95004267. Source: OSTI; NTIS; GPO Dep.

EXODUS II is a model developed to store and retrieve data for finite element analyses. It is used for preprocessing (problem definition), postprocessing (results visualization), as well as code to code data transfer. An EXODUS II data file is a random access, machine independent, binary file that is written and read via C, C++, or Fortran library routines which comprise the Application Programming Interface (API).

7060 (SAND–94-2420C) **Dynamic load balancing for parallel finite element methods with adaptive h- and p-refinement.** Devine, K.D. (Sandia National Labs., Albuquerque, NM (United States)); Flaherty, J.E. Sandia National Labs., Albuquerque, NM (United States). [1994]. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950212–4: 7. SIAM conference on parallel processing for scientific computing, San Francisco, CA (United States), 15-17 Feb 1995). Order Number DE95004521. Source: OSTI; NTIS; GPO Dep.

We describe a dynamic load-balancing strategy for parallel finite element methods with adaptive mesh (h-) and order (p-) refinement. The load-balancing algorithm is based on the tiling load-balancing system, where global balance in achieved by performing local balancing within overlapping neighborhoods of processors. Tiling is applied to each mesh level created by the adaptive h-refinement. Weights are used in the migration routines to reflect the nonuniform elemental work loads caused by adaptive p-refinement. The combination of adaptive refinement and tiling

significantly reduces total execution time relative to fixed-mesh, fixed-order methods yielding comparable accuracy, as we demonstrate with experiments on an nCUBE/2.

7061 (SAND–94-2444C) **Parallel algorithms for dynamically partitioning unstructured grids.** Diniz, P. (University of California, Santa Barbara (United States). Dept. of Computer Science); Plimpton, S.; Hendrickson, B.; Leland, R. Sandia National Labs., Albuquerque, NM (United States). [1994]. 6p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950212–2: 7. SIAM conference on parallel processing for scientific computing, San Francisco, CA (United States), 15-17 Feb 1995). Order Number DE95001616. Source: OSTI; NTIS; GPO Dep.

Grid partitioning is the method of choice for decomposing a wide variety of computational problems into naturally parallel pieces. In problems where computational load on the grid or the grid itself changes as the simulation progresses, the ability to repartition dynamically and in parallel is attractive for achieving higher performance. We describe three algorithms suitable for parallel dynamic load-balancing which attempt to partition unstructured grids so that computational load is balanced and communication is minimized. The execution time of algorithms and the quality of the partitions they generate are compared to results from serial partitioners for two large grids. The integration of the algorithms into a parallel particle simulation is also briefly discussed.

7062 (SAND–94-3112C) **A review of research and methods for producing high-consequence software.** Collins, E.; Dalton, L.; Peercy, D.; Pollock, G.; Sicking, C. Sandia National Labs., Albuquerque, NM (United States). [1994]. 51p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-950258–1: 1995 Institute of Electrical and Electronics Engineers (IEEE) aerospace applications conference, Snowmass, CO (United States), 13-17 Feb 1995). Order Number DE95004522. Source: OSTI; NTIS; GPO Dep.

The development of software for use in high-consequence systems mandates rigorous (formal) processes, methods, and techniques to improve the safety characteristics of those systems. This paper provides a brief overview of current research and practices in high-consequence software, including applied design methods. Some of the practices that are discussed include: fault tree analysis, failure mode effects analysis, petri nets, both hardware and software interlocks, n-version programming, Independent Vulnerability Analyses, and watchdogs. Techniques that offer improvement in the dependability of software in high-consequence systems applications are identified and discussed. Limitations of these techniques are also explored. Research in formal methods, the cleanroom process, and reliability models are reviewed. In addition, current work by several leading researchers as well as approaches being used by leading practitioners are examined.

7063 (UCRL-JC–116899) **A technical approach for determining the importance of information in computerized alarm systems.** Fortney, D.S. (Lawrence Livermore National Lab., CA (United States)); Lim, J.J. Lawrence Livermore National Lab., CA (United States). 10 Jun 1994. 12p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-9410140–2: 17. national computer security conference, Baltimore, MD (United States), 11-14 Oct 1994). Order Number DE95004211. Source: OSTI; NTIS; GPO Dep.

Computerized alarm and access control systems must be treated as special entities rather than as generic automated information systems. This distinction arises due to the real-time control and monitoring functions performed by these systems at classified facilities and the degree of centralization of a site's safeguards system information in the associated databases. As an added requirement for these systems, DOE safeguards and security classification policy is to protect information whose dissemination has the potential for significantly increasing the probability of successful adversary action against the facility, or lowering adversary resources needed for a successful attack. Thus at issue is just how valuable would specific alarm system information be to an adversary with a higher order objective. We have developed and applied a technical approach for determining the importance of information contained in computerized alarm and access control systems. The methodology is based on vulnerability assessment rather than blanket classification rules. This method uses a system architecture diagram to guide the analysis and to develop adversary defeat methods for each node and link. These defeat methods are evaluated with respect to required adversary resources, technical difficulty, and detection capability. Then they are incorporated into site vulnerability assessments to determine the significance of alarm system information in the context of a facility attack. This methodology was successfully applied to the Argus alarm, access control, and assessment system developed at the Lawrence Livermore National Lab. Argus is software-driven, contains interrelated databases, shares host computers, and communicates with field processors and alarms through a common network. The evaluation results provided insights into the importance of alarm system information while the methodology itself provided a framework for addressing associated information protection issues.

7064 (UCRL-JC–118448) **Debugging the virtual machine.** Miller, P.; Pizzi, R. Lawrence Livermore National Lab., CA (United States). 2 Sep 1994. 15p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-48. (CONF-950242–1: Symposium on applied computing (SAC '95), Nashville, TN (United States), 26-28 Feb 1995). Order Number DE95002193. Source: OSTI; NTIS; GPO Dep.

A computer program is really nothing more than a virtual machine built to perform a task. The program's source code expresses abstract constructs using low level language features. When a virtual machine breaks, it can be very difficult to debug because typical debuggers provide only low level machine implementation in formation to the software engineer. We believe that the debugging task can be simplified by introducing aspects of the abstract design into the source code. We introduce OODIE, an object-oriented language extension that allows programmers to specify a virtual debugging environment which includes the design and abstract data types of the virtual machine.

7065 (WHC-SD-GN-ER–30033) **Verification and validation of decision support software: Expert Choice™ and PCM™.** Nguyen, Q.H.; Martin, J.D. Westinghouse Hanford Co., Richland, WA (United States). 4 Nov 1994. 63p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004469. Source: OSTI; NTIS; GPO Dep.

This report documents the verification and validation of two decision support programs: EXPERT CHOICE™ and PCM™. Both programs use the Analytic Hierarchy Process (AHP) – or pairwise comparison technique – developed by Dr. Thomas L. Saaty. In order to provide an independent method for the validating the two programs, the pairwise comparison algorithm was developed for a standard mathematical program. A standard data set – selecting a car to purchase – was used with each of the three programs for validation. The results show that both commercial programs performed correctly.

9903 Information Handling

Refer also to citation(s) 5029, 5231, 5237, 5248, 5256, 5305, 5314, 5617, 5618, 5620, 5621, 5718, 5721, 6011, 6359, 6587, 7021, 7035, 7037, 7049

7066 (CRIE-R–93003) **Survey on introducing expert systems in office works at electric power companies.** Usagawa, T.; Bannai, K. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Jan 1994. 21p. (In Japanese). Order Number DE95730178. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

A survey was made on the following themes to be appropriately applied to the expert system for the office work in the electric power company: business-related themes to support the dealing with clients, accumulation of basic business know-how and retrieval of detailed charges. General-affairs related themes to support the consultation about the stock and compensation for the damage, and business procedure in the company. The application of expert systems which are common to all the themes aims at the four items which are accumulation and common application of business

know-how, business progress management, educational support, and self-enlightenment. It is important to clearly comprehend those items for establishing the expert system. The needs-related concept and efficiency-related concept are called for in the selection of themes. The former concept covers the service improvement, business efficiency heightening, resources saving and degree of needs, while the latter does the degree of generalization, management unification, accumulation of know-how and experience, degree of appeal, and educational support. The model system must be experimentally built for the execution. 2 refs., 7 tabs.

7067 (CRIE-R–93015) **Integrated resource management database for a distributed information system.** Futakata, A. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Mar 1994. 24p. (In Japanese). Order Number DE95730180. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

An integrated resource management database was reported which was developed for the distributed information system. In that system, various systems fluctuate fluidly with dispersion of information resources such as data and process. Therefore, relation is difficult to grasp among those resources, and the information system is also difficult to manage. In order to express those resources and their mutual relation, a business information model which could give both data-oriented and process-oriented views was developed and so hierarchically structured as to detail the description. Based on that model, an integrated resource management database was further developed which generalized and managed the information resources. Thus, the influence analysis of change in system and maintenance of data conformity are expected to be eased. A system was also experimentally prepared which supported the structure based on a proposed methodology to structure the business information model. As a result, it was confirmed that the present database is easy to grasp by the managers and excellent in maintenance properties. 12 refs., 10 figs., 1 tab.

7068 (CRIE-R–94001) **Survey of methods for secure connection to the internet.** Matsui, S. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1994. 24p. (In Japanese). Order Number DE95730185. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

This paper describes a study of a security method of protecting inside network computers against outside miscreants and unwelcome visitors and a control method when these computers are connected with the Internet. In the present Internet, a method to encipher all data cannot be used, so that it is necessary to utilize PEM (Privacy Enhanced Mail) capable of the encipherment and conversion of secret information. For preventing miscreant access by eavesdropping password, one-time password is effective. The most cost-effective method is a firewall system. This system lies between the outside and inside network. By limiting computers that directly communicate with the Internet, control is centralized and inside network Security is protected. If the security of firewall systems is strictly controlled under correct setting, security within the network can be secured even in open networks such as the Internet. 35 refs., 3 figs.

7069 (CRIE-R–94002) **Downsizing systems and expected opposition to introduction.** Tokoro, K. Central Research Inst. of Electric Power Industry, Tokyo (Japan). Apr 1994. 27p. (In Japanese). Order Number DE95730186. Source: OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan.

The proper use of downsizing systems and mainframe systems was studied for the purpose of introducing, advantages of downsizing while utilizing existing information systems. Downsizing has four features: high cost performance, high flexibility and expandability, highly functional interface, and a horizontal linkage system. But compared with centralized systems, downsizing systems entail higher operation and control costs. Downsizing introduction technology has not yet been established in the field of systematization where renewal of corporate data, high security, and mass high-speed printing are required. Downsizing is suitable for fields where systematization is difficult with centralized systems, characteristics of downsizing can be fully demonstrated, and advanced and established technology is not needed. Specific examples of its application are the support of decision making, creative work, and group operation. For improving the performance of the downsizing system as a whole, its application to computers on the network, and distributed data arrangement are important. 15 refs.

7070 (DOE/DP/70033–T1) **Research and development of models and instruments to define, measure, and improve shared information processing with government oversight agencies. An analysis of the literature, August 1990–January 1992.** Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States). Management Systems Labs. [1992]. 103p. Sponsored by USDOE, Washington, DC (United States). DOE Contract FG05-86DP70033. Order Number DE94017792. Source: OSTI; NTIS; GPO Dep.

This document identifies elements of sharing, plus key variables of each and their interrelationships. The document's model of sharing is intended to help management systems' users understand what sharing is and how to integrate it with information processing.

7071 (DOE/HR–0083) **Information technology standards process guide.** USDOE Assistant Secretary for Human Resources and Administration, Washington, DC (United States). Apr 1994. 33p. Sponsored by USDOE, Washington, DC (United States). Order Number DE95003967. Source: OSTI; NTIS; GPO Dep.

This document presents a logical and realistic approach to implementation of the Information Technology Standards Program throughout the Department and its management and operating contractors, as described in Department of Energy 1360.3C, Information Technology Standards, dated October 19, 1992. To take better advantage of commercial advances and investments in information technology resources, it is paramount that the Department of Energy move as rapidly as programmatically feasible to an open systems environment. The process revolves around the selection of interface standards in areas such as multi-system and multi-processor interconnects, operating and database management systems, graphics, and security. This new approach will result in reduced production, operation, and maintenance costs, and more effective system integration. The Information Technology Standards Process Guide provides a model that may be tailored to Department of Energy sites. It also assists sites in understanding the Information Technology Standards Program. It is not an architectural description to be used in implementing a corporate information systems environment.

7072 (ES/ER/TM–120/V3) **Information management architecture for an integrated computing environment for the Environmental Restoration Program. Environmental Restoration Program, Volume 3, Interim technical architecture.** Oak Ridge National Lab., TN (United States). Sep 1994. 119p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC05-84OR21400. Order Number DE95001386. Source: OSTI; NTIS; INIS; GPO Dep.

This third volume of the Information Management Architecture for an Integrated Computing Environment for the Environmental Restoration Program–the Interim Technical Architecture (TA) (referred to throughout the remainder of this document as the ER TA)–represents a key milestone in establishing a coordinated information management environment in which information initiatives can be pursued with the confidence that redundancy and inconsistencies will be held to a minimum. This architecture is intended to be used as a reference by anyone whose responsibilities include the acquisition or development of information technology for use by the ER Program. The interim ER TA provides technical guidance at three levels. At the highest level, the technical architecture provides an overall computing philosophy or direction. At this level, the guidance does not address specific technologies or products but addresses more general concepts, such as the use of open systems, modular architectures, graphical user interfaces, and architecture-based development. At the next level, the technical architecture provides specific information technology recommendations regarding a wide variety of specific technologies. These technologies include computing hardware, operating systems, communications software, database management software, application development software, and personal productivity software, among others. These recommendations range from the adoption of specific

industry or Martin Marietta Energy Systems, Inc. (Energy Systems) standards to the specification of individual products. At the third level, the architecture provides guidance regarding implementation strategies for the recommended technologies that can be applied to individual projects and to the ER Program as a whole.

7073 (LA-UR–94-3835) **A network-based distributed, media-rich computing and information environment.** Phillips, R.L. Los Alamos National Lab., NM (United States). [1995]. 13p. Sponsored by USDOE, Washington, DC (United States). DOE Contract W-7405-ENG-36. (CONF-941118–9: Supercomputing '94 meeting; Digital media and electronic publishing conference, Washington, DC (United States); Leeds (United Kingdom), 14-18 Nov 1994; 6-8 dec 1994; CONF-941243–1). Order Number DE95003696. Source: OSTI; NTIS; GPO Dep.

Sunrise is a Los Alamos National Laboratory (LANL) project started in October 1993. It is intended to be a prototype National Information Infrastructure development project. A main focus of Sunrise is to tie together enabling technologies (networking, object-oriented distributed computing, graphical interfaces, security, multi-media technologies, and data-mining technologies) with several specific applications. A diverse set of application areas was chosen to ensure that the solutions developed in the project are as generic as possible. Some of the application areas are materials modeling, medical records and image analysis, transportation simulations, and K-12 education. This paper provides a description of Sunrise and a view of the architecture and objectives of this evolving project. The primary objectives of Sunrise are three-fold: (1) To develop common information-enabling tools for advanced scientific research and its applications to industry; (2) To enhance the capabilities of important research programs at the Laboratory; (3) To define a new way of collaboration between computer science and industrially-relevant research.

7074 (SAND–94-2764C) **The energy intelligence information system.** Malczynski, L. Sandia National Labs., Albuquerque, NM (United States). [1994]. 11p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC04-94AL85000. (CONF-9410237–1: 1994 Geographic Information Systems/Land Information Systems (GIS/LIS), Phoenix, AZ (United States), 25-27 Oct 1994). Order Number DE95002184. Source: OSTI; NTIS; GPO Dep.

The safety and security of foreign nuclear facilities is an important topic for intelligence services. This has been made more important by the breakup of the Former Soviet Union. The major requirement of intelligence analysts is rapid information retrieval after the report of an incident at a foreign facility. Sandia National Laboratories is developing a GIS-based Energy Intelligence Information System (EIIS) to help analysts at The Office of Energy Intelligence of the Department of Energy formulate a response to a nuclear incident. The Vital Issues process was used to determine which information might be the most important to collect. Joint Applications Design and prototyping sessions were held to establish EIIS requirements and refine the user interface. EIIS was built to access any point on the globe or to move directly to a site, facility, or city. The EIIS version 1.0 concentrates on commercial reactors, version 2.0 will include other nuclear fuel cycle sites and release 3.0 will include waste and disposal information. The system runs on a SUN workstation using ARC/INFO™ and Informix as the RDBMS. The map system relies upon the Digital Chart of the World from the Defense Mapping Agency.

7075 (WHC-SA–2594) **Measuring the strategic value of information technology investments.** Conrad, K.W. (Boeing Computer Services Co., Richland, WA (United States)). Westinghouse Hanford Co., Richland, WA (United States). Aug 1994. 38p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. (CONF-940873–3: 11. office information technology conference, Chicago, IL (United States), 23-25 Aug 1994). Order Number DE94018160. Source: OSTI; NTIS; INIS; GPO Dep.

Value is often perceived differently by the proponents of new information technologies and those who allocate resources and define priorities. Such differences often become a roadblock to meeting true business needs. Project justifications regularly rely on calculated cost savings, which rarely measure the full benefit of new technologies. In fact, if cost savings provide a complete picture, then the organization is probably just automating routine clerical operations and has abandoned efforts that would provide significant strategic value. Strategic value is not limited to financial calculations, but includes quality, time and risk criteria. This paper describes approaches for measuring strategic value that can provide organizations with proven techniques to improve performance, reengineer processes, benchmark performance against other suppliers, identify outsourcing opportunities, or defend themselves from pressures to outsource. Many organizations respond to tightening budgets by cutting overhead. These measurement approaches can demonstrate how overhead is critical to organizational effectiveness and how cost savings can be found, instead, by measurably improving performance throughout the organization. Finally, the paper describes efforts underway within the Department of Energy and at the Hanford Site to implement the approaches described in this paper.

7076 (WHC-SD-GN-CSDD–30006-Rev.1) **Search Hanford accessible reports electronically system design description. Revision 1.** Gilomen, T.L. Westinghouse Hanford Co., Richland, WA (United States). [1995]. 45p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004369. Source: OSTI; NTIS; GPO Dep.

The Search Hanford Accessible Records Electronically (SHARE) system was produced by a combined team of personnel from Westinghouse Hanford Company (WHC) Corrective Action Data Systems (CADS) and Information Resource Management (IRM) Information and Scientific Systems (ISS) organizations. The ESQD Text Evaluation and exchange Tool (ETEXT) prototype was used as a basis for the requirements used to support this design/build effort. TOPIC was used to build the SHARE application. TOPIC is a text search and retrieval software product produced by the Verity Corporation. The TOPIC source code is not provided with the product, and the programs cannot be changed. TOPIC can be customized for special requirements. The software is fully documented. Help messages, menu and screen layouts, command edits and options, and internal system design are all described in the TOPIC documentation. This System Design Description (SDD) will not reiterate the TOPIC documentation and design. Instead, it will focus on the SHARE installation of TOPIC. This SDD is designed to assist the SHARE database/infobase administrator (DBA) in maintaining and supporting the application. It assumes that the assigned DBA is knowledgeable in using the TOPIC product, and is also knowledgeable in using a personal computer (PC), Disk Operating System (DOS) commands, and the document WHC-CM-3-10. SHARE is an Impact Level 4 system, and all activities related to SHARE must conform with the WHC-CM-3-10 procedures for an Impact Level 4 system. The Alternatives Analysis will be treated as a level 3-Q document, to allow for reference by potential future projects.

7077 (WHC-SD-GN-CSRS–30008-Rev.1) **Search Hanford accessible reports electronically system requirements specification.** Willers, K.J. Westinghouse Hanford Co., Richland, WA (United States). 28 Feb 1994. 24p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004367. Source: OSTI; NTIS; GPO Dep.

The Emergency, Safety, & Quality (ESQ) Services organization of Westinghouse Hanford Company (WHC) is experiencing changes related to new programs. The programs include Corrective Actions Management Systems, Self-Assessment, Trend Analysis, and Lessons Learned analysis. The programs are pushing up organizational costs while funding and manpower levels are projected to be dropping. A large cost involved in implementing the new programs is the cost for people to locate unstructured information required to make decisions or write documentation. But, most resources for retrieving information are found in structured database systems. This means that unstructured information that must be located has to be found by one of these methods: (1) searching manually through documents, (2) searching individual documents one at a time with word processing programs, (3) searching through text fields with query systems primarily designed for structured database information, or (4) develop a text search and retrieval system designed for unstructured information. One example of this is using Occurrence Reporting Processing System

(ORPS) and Quality, Environmental, and Safety Tracking (QUEST) documents. An explanation of this is in the following textual box.

7078 (WHC-SD-GN-CSWD–30057-Rev.1) **Search Hanford Accessible Reports Electronically system test plan and documentation: Revision 1.** White, E.L. Westinghouse Hanford Co., Richland, WA (United States). 7 Dec 1994. 32p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004368. Source: OSTI; NTIS; GPO Dep.

The purpose of this document is to describe the following items: the approach, resources, and sequence of the testing activities; identifies the components and features to be tested; the personnel responsible for testing; the risks associated with this plan; and test cases and procedures. This document contains all test documentation for the SHARE system. The Search Hanford Accessible Reports Electronically (SHARE) testing process is based upon WHC-CM-3-10, Software Practices, Section SP-3.3 REV 0, and Appendix J REV 0. These procedures and guidelines are based on IEEE Standard 829-1983. The planning in this document was further influenced through guidance in IEEE Standard 1012-1986. This document contains the System, Acceptance, Integration and Component Test Plans, Designs, Procedures, and Cases for SHARE. The Test Cases and procedures have been attached to the document.

7079 (WHC-SD-GN-SP–30001) **HIMACS file management software and strategies.** Rohen, W.T. Westinghouse Hanford Co., Richland, WA (United States). 30 Sep 1994. 19p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95004109. Source: OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.

This document discusses the various file management technologies available for potential use with microcomputers at Hanford.

7080 (WHC-SD-HWV-UM–004-Rev.1) **Activity Management System user reference manual. Revision 1.** Gates, T.A.; Burdick, M.B. Westinghouse Hanford Co., Richland, WA (United States). 22 Sep 1994. 105p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95000989. Source: OSTI; NTIS; INIS; GPO Dep.

The Activity Management System (AMS) was developed in response to the need for a simple-to-use, low-cost, user interface system for collecting and logging Hanford Waste Vitrification Plant Project (HWVP) activities. This system needed to run on user workstations and provide common user access to a database stored on a local network file server. Most important, users wanted a system that provided a management tool that supported their individual process for completing activities. Existing system treated the performer as a tool of the system. All AMS data is maintained in encrypted format. Users can feel confident that any activities they have entered into the database are private and that, as the originator, they retain sole control over who can see them. Once entered into the AMS database, the activities cannot be accessed by anyone other than the originator, the designated agent, or by authorized viewers who have been explicitly granted the right to look at specific activities by the originator. This user guide is intended to assist new AMS users in learning how to use the application and, after the initial learning process, will serve as an ongoing reference for experienced users in performing infrequently used functions. Online help screens provide reference to some of the key information in this manual. Additional help screens, encompassing all the applicable material in this manual, will be incorporated into future AMS revisions. A third, and most important, source of help is the AMS administrator(s). This guide describes the initial production version of AMS, which has been designated Revision 1.0.

7081 (WHC-SD-WM-DP–089) **Data management plan for the ultrasonic inspection of the double-shell tanks.** Harris, J. Westinghouse Hanford Co., Richland, WA (United States). 30 Sep 1994. 7p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95001542. Source: OSTI; NTIS; INIS; GPO Dep.

To obtain an operating permit from Washington State Department of Ecology, Westinghouse Hanford Company (WHC) must assess the double-shell tanks (DST) for structural integrity. The assessment includes volumetric examinations of the primary steel tank and secondary steel liner. The integrity of the tanks will be assessed by remote ultrasonic (UT) inspections of the primary and secondary steel tanks to measure wall thickness and detect corrosion pitting and stress corrosion cracking. The surfaces of the areas to be inspected will be cleaned with a power wire brush to remove loose mill scale, rust, and other materials that could inhibit proper coupling of the UT probe. To ensure that the cleaning process is satisfactory, the cleaned area will be viewed with a video camera and recorded. The video and UT equipment will be calibrated the ensure accuracy, and a performance test will be conducted to verify its capabilities. The tank inspection sequence consists of cleaning, visual examination, and UT inspection of each region selected for inspection: the primary tank wall, the tank bottom and lower knuckle, and the secondary tank wall. A significant amount of data will be collected and reported during these examinations. This data management plan (DMP) describes the data produced by the examinations and how and where the data are to be stored.

7082 (WHC-SD-WM-SWD–015) **Liquid Effluent Monitoring Information System (LEMIS) System Construction.** Adams, R.T. Westinghouse Hanford Co., Richland, WA (United States). 11 Oct 1994. 82p. Sponsored by USDOE, Washington, DC (United States). DOE Contract AC06-87RL10930. Order Number DE95002242. Source: OSTI; NTIS; INIS; GPO Dep.

The liquid effluent sampling program is part of the effort to minimize adverse environmental impact during the cleanup operation at the Hanford Site. Of the 33 Phase I and Phase II liquid effluents, all streams actively discharged to the soil column will be sampled. The Liquid Effluent Monitoring Information System (LEMIS) is being developed as the organized information repository facility in support of the liquid effluent monitoring requirements of the Tri-Party Agreement. It is necessary to provide an automated repository into which the results from liquid effluent sampling will be placed. This repository must provide for effective retention, review, and retrieval of selected sample data by authorized persons and organizations. This System Construction document is the aggregation of the DMR P+ methodology project management deliverables. Together they represent a description of the project and its plan through four Releases, corresponding to the definition and prioritization of requirements defined by the user.

9904 Law

Refer also to citation(s) 5694

7083 (INIS-mf–14425) **Statutory Instrument No 48 of 1992. Radiological Protection Act, 1991 (Establishment day) Order, 1992.** Ireland. Mar 1992. 1p. Order Number DE95611312. Source: OSTI; NTIS (US Sales Only); INIS.

This order appoints 1st April 1992 as the day on which the Radiological Protection Institute of Ireland is established. From that day the Radiological Protection Institute of Ireland will take over the functions of An Bord Fuinnimh Nuicleigh.

7084 (INIS-mf–14426) **Statutory Instrument No 144 of 1992. Convention on assistance in the case of a nuclear accident or radiological emergency (privileges and immunities) order, 1992.** Ireland. Feb 1992. 7p. Order Number DE95611313. Source: OSTI; NTIS (US Sales Only); INIS.

This Order is made by the power conferred on the Government by Section 42A of the Diplomatic Relations and Immunities Acts, 1967 and 1976. It enables the Government to afford immunity from legal action and exemption from taxes to foreign rescue workers as required under Article 8 of the Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency to which the State is a party.

7085 (INIS-mf–14427) **Statutory Instrument No 151 of 1993. Radiological Protection Act, 1991 (General control of radioactive substances, nuclear devices and irradiating apparatus) Order, 1993.** Ireland. Jun 1993. 12p. Order Number DE95611314. Source: OSTI; NTIS (US Sales Only); INIS.

This Order has the effect of revoking and replacing the Nuclear Energy (General Control of Fissile Fuels, Radioactive Substances

and Irradiating Apparatus) Order, 1977 (S.I. No. 166 of 1977). It provides for the control by licence, to be obtained from the Radiological Protection Institute of Ireland, of the custody, transportation, handling, holding, storage, use, manufacture, production, processing, importation, distribution, exportation, or other disposal of radioactive substances, nuclear devices or irradiating apparatus, as defined in the Order. This Order also completes the implementation of Council Directive 80/836/EURATOM of 15 July, 1980, as amended by Council Directive 84/467/EURATOM of 3 September, 1984, laying down the basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation.

7086 (INIS-XN–507) **Cooperation Agreement between the Government of Australia and the European Orgaization for Nuclear Research (CERN) concerning the further development of scientific and technical co-operation in the research projects of CERN Ministry - Regulatory Decree No 3/92 of 6 March.** Australia. 1 Nov 1991. 7p. Order Number DE95611309. Source: OSTI; NTIS (US Sales Only); INIS.

The agreement provides for co-operation on research projects. Australian specialists may participate in CERN research projects, in particular in connection with the Large Electron-Position Collider-LEP. The Agreement entered into force on the date of its signature for an initial period of five years and is renewable. (NEA).

Corporate Author Index

This index lists the corporate authors responsible for issuing the documents in this publication which are identified primarily by report number. The corporate names are entered in standardized forms as defined in ETDE/PUB–3 (Rev.1), *International Energy: Research Organizations 1988–1992*. Each entry under a corporate name includes the document title and citation number. Three items of information may appear in parentheses: (1) an abbreviation to identify the document type, such as a report; (2) the country of publication, indicated by International Organization for Standardization (ISO) country code; and (3) the language of the document if non-English (R;CA;In French). Author affiliations are not listed in this index.

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AC21-92MC29245	Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center	
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AC21-92MC29261	Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center	
	20:5684	DOE/METC–94/1008-Vol.2
AC21-92MC29470	USDOE Morgantown Energy Technology Center, WV (United States)	
	20:5057	DOE/METC–94/1002
AC21-93MC28139	Energy and Environmental Analysis, Inc., Arlington, VA (United States)	
	20:5031	DOE/MC/28139–3929
	USDOE Morgantown Energy Technology Center, WV (United States)	
	20:5029	DOE/METC–94/1002
AC21-93MC29240	USDOE Morgantown Energy Technology Center, WV (United States)	
	20:5084	DOE/METC–94/1002
AC22-86PC90751	Physical Sciences, Inc., Andover, MA (United States)	
	20:7051	ESTSC–000776IB48600
AC22-87PC79672	TRW Space and Electronics Group, Redondo Beach, CA (United States)	
	20:6075	DOE/PC/79672–T9
AC22-88ID12735	Argonne National Lab., IL (United States)	
	20:5130	ANL/CMT/CP–82509
	MSE, Inc., Butte, MT (United States)	
	20:6074	DOE/ID/12735–T33
AC22-88PC88881	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-89BC14475	Lawrence Berkeley Lab., CA (United States)	
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AC22-89PC88654	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-90PC90044	Lehigh Univ., Bethlehem, PA (United States)	
	20:4898	DOE/PC/90044–T2
AC22-90PC90165	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-90PC90177	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-91PC90360	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-91PC90365	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-91PC91154	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-91PC91161	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-91PC91162	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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	Coal Tech Corp., Merion Station, PA (United States)	
	20:5667	DOE/PC/91162–T11
AC22-91PC91164	Virginia Polytechnic Inst., Blacksburg, VA (United States)	
	20:4885	DOE/PC/91164–T10
AC22-92PC91050	Canadian Energy Development, Inc., Edmonton, AB (Canada)	
	20:4899	DOE/PC/91050–T8-Vol.3
AC22-92PC91155	United Technologies Corp., East Hartford, CT (United States). Research Center	
	20:5666	DOE/PC/91155–T7
	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-92PC91344	SRI International, Menlo Park, CA (United States)	
	20:4943	DOE/PC/91344–T9
AC22-92PC92117	Michigan Biotechnology Inst., Lansing, MI (United States)	
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AC22-92PC92158	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-92PC92159	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-92PC92208	AMAX Research and Development Center, Golden, CO (United States)	
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AC22-92PC92246	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-93PC92114	Institute of Gas Technology, Chicago, IL (United States)	
	20:5544	DOE/PC/92114–T4
AC22-93PC92116	Delaware Univ., Newark, DE (United States). Dept. of Chemical Engineering	
	20:5545	DOE/PC/92116–T3
	20:5546	DOE/PC/92116–T4
AC22-93PC92190	PSI Technology Co., Andover, MA (United States)	
	20:4987	DOE/PC/92190–T5
AC22-93PC92206	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC22-93PC93051	Pennsylvania State Univ., University Park, PA (United States). Coal and Organic Petrology Labs.	
	20:4917	DOE/PC/93051–T3
AC22-93PC93251	Battelle Columbus Operations, OH (United States)	
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AC22-93PC93254	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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AC24-92OR21972	Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States). Fernald Environmental Management Project	
	20:5413	FEMP–2321
	20:5415	FEMP–2338
	20:5416	FEMP–2390
	Fernald Environmental Restoration Management Corp., Cincinnati, OH (United States)	
	20:5417	FEMP/SUB–058
	Fluor Daniel Environmental Restoration Management Corp., Fernald, OH (United States)	
	20:5414	FEMP–2336
AC34-90DP62349	EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant	
	20:5432	RFP-ENV–93
AC34-90RF62349	EG and G Rocky Flats, Inc., Golden, CO (United States). Rocky Flats Plant	
	20:5207	RFP–4641
AC36-83CH10093	National Renewable Energy Lab., Golden, CO (United States)	
	20:5560	NREL/TP–410-7408
	20:5568	NREL/TP–471-7017
	20:5569	NREL/TP–471-7019
	20:5575	DOE/CH/10093–350
	20:5588	NREL/TP–471-7294
	20:5589	NREL/TP–472-7295
	20:5646	NREL/TP–442-7109
	20:5647	NREL/TP–442-7228
	20:6034	NREL/TP–472-7293
	20:6083	NREL/TP–463-6831
	20:6092	DOE/CH/10093–251
	20:6093	DOE/CH/10093–332
	20:6132	NREL/TP–430-7382
	20:6142	NREL/TP–425-6354
	20:6360	DOE/CH/10093–298
AI08-91NV11040	Geological Survey, Carson City, NV (United States)	
	20:5369	USGS/OFR–94-491
AI08-92NV10874	Geological Survey, Denver, CO (United States)	
	20:5218	USGS-OFR–93-540-A
	20:5219	USGS-OFR–93-586-A
	20:5220	USGS/WRI–92-4016
	USDOE Nevada Operations Office, Las Vegas, NV (United States)	
	20:5217	USGS-OFR–92-458
AI21-86MC23120	USDOE Morgantown Energy Technology Center, WV (United States)	
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AR21-93MC30362	Carnegie-Mellon Univ., Pittsburgh, PA (United States). Robotics Inst.	
	20:6307	DOE/MC/30362–95/C0405
AS03-76ER70285	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
	20:6430	SLAC-PUB–6714
AS07-80ID12082	Environmental Science and Research Foundation, Idaho Falls, ID (United States)	
	20:5408	DOE/ID–12082(93)
Contract AC02-80EV10449	Indiana Univ. Foundation, Bloomington, IN (United States)	
	20:6622	DOE/EV/10449–T2
FC08-93NV11417	Nevada Univ., Reno, NV (United States). Desert Research Inst.	
	20:5156	DOE/NV/11417–6
FC21-86MC11076	Western Research Inst., Laramie, WY (United States)	
	20:4890	DOE/MC/11076–3828
FC21-89MC26042	Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center	
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FC21-89MC26268	USDOE Morgantown Energy Technology Center, WV (United States)	
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FC21-90MC26029	USDOE Morgantown Energy Technology Center, WV (United States)	
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FC21-90MC27229	Thermochem, Inc., Columbia, MD (United States)	
	20:4979	DOE/MC/27229–3948
FC21-90MC27286	USDOE Morgantown Energy Technology Center, WV (United States)	
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FC21-91MC28060	Dravo Lime Co., Pittsburgh, PA (United States)	
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	20:4931	DOE/MC/28060–3949
FC21-92MC27391	Institute of Gas Technology, Chicago, IL (United States)	
	20:4889	CONF-921037–12
FC21-92MC28178	USDOE Morgantown Energy Technology Center, WV (United States)	
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FC21-92MC29077	USDOE Morgantown Energy Technology Center, WV (United States)	
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FC21-92MC29264	Massachusetts Inst. of Tech., Cambridge, MA (United States)	
	20:4980	DOE/MC/29264–3933
FC21-92MC29309	Sierra Pacific Power Co., Reno, NV (United States)	
	20:5661	DOE/MC/29309–95/C0408
FC21-92MC29467	National Research Center for Coal and Energy, Morgantown, WV (United States)	
	20:6548	DOE/MC/29467–3939
FC21-93MC30070	USDOE Morgantown Energy Technology Center, WV (United States)	
	20:5045	DOE/METC–94/1002
FC21-93MC30127	Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center	
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FC21-93MC30251	Kentucky Univ., Lexington, KY (United States). Center for Applied Energy Research	
	20:4932	DOE/MC/30251–3938
FC22-83FE60149	National Inst. for Petroleum and Energy Research, Bartlesville, OK (United States)	
	20:5022	NIPER–620
FC22-90PC89651	Woodward Clyde Consultants, Santa Ana, CA (United States)	
	20:5688	DOE/PC/89651–T15
FC22-90PC89659	Babcock and Wilcox Co., Cassville, WI (United States)	
	20:4984	DOE/PC/89659–T15
FC22-92PC92162	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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FC22-92PC92521	Illinois Dept. of Energy and Natural Resources, Springfield, IL (United States)	
	20:4886	DOE/PC/92521–T179

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FC22-93BC14950	Sierra Energy Co., Reno, NV (United States)	
	20:5009	DOE/BC/14950–4
FC22-93BC14958	Lomax Exploration Co., Salt Lake City, UT (United States)	
	20:5010	DOE/BC/14958–8
FC22-93PC92578	Missouri Univ., Columbia, MO (United States). Capsule Pipeline Research Center	
	20:4958	DOE/PC/92578–T3
FC22-94PC94110	TECOGEN, Inc., Waltham, MA (United States)	
	20:6354	DOE/PC/94110–T1
FG01-89CE90049	Hansen Engine Corp., Minnetonka, MN (United States)	
	20:6137	DOE/CE/90049–T1
FG01-92CE15529	Thermodyne Evaporators, Portland, ME (United States)	
	20:6111	DOE/CE/15529–T1
FG01-92CE15974	Nebraska Univ., Lincoln, NE (United States)	
	20:6244	DOE/CE/15974–T9
FG01-93MI10270	Southeastern Consortium for Minorities in Engineering, Atlanta, GA (United States)	
	20:6641	DOE/MI/10270–T3
	20:6642	DOE/MI/10270–T5
FG01-94CE15554	Mississippi State Univ., MS (United States). Forest Products Lab.	
	20:6112	DOE/CE/15554–T2
FG01-94CE15612	Synfuels Engineering and Development, Inc., Arvada, CO (United States)	
	20:5538	DOE/CE/15612–T2
FG02-85ER13406	Wisconsin Univ., Madison, WI (United States)	
	20:6280	DOE/ER/13406–9
FG02-85ER53198	Wisconsin Univ., Madison, WI (United States). Plasma Physics Research	
	20:6866	DOE/ER/53198–251
FG02-86ER13631	Arizona Univ., Tucson, AZ (United States). Dept. of Biochemistry	
	20:5556	DOE/ER/13631–T2
FG02-87ER13775	State Univ. of New York, Buffalo, NY (United States). Dept. of Chemistry	
	20:6281	DOE/ER/13775–6
FG02-87ER40317	State Univ. of New York, Stony Brook, NY (United States). Dept. of Earth and Space Sciences	
	20:6651	DOE/ER/40317–13
FG02-87ER60561	Michigan Univ., Ann Arbor, MI (United States)	
	20:6590	DOE/ER/60561–10
FG02-88ER40388	Lawrence Berkeley Lab., CA (United States)	
	20:6688	LBL–34831
FG02-88ER40448	Rensselaer Polytechnic Inst., Troy, NY (United States). Dept. of Physics	
	20:6684	DOE/ER/40448–T1
FG02-90ER20019	Massachusetts Inst. of Tech., Cambridge, MA (United States)	
	20:6583	DOE/ER/20019–T1
FG02-90ER80897	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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FG02-91CE23810	Illinois Univ., Urbana, IL (United States). Dept. of Mechanical and Industrial Engineering	
	20:6113	DOE/CE/23810–45
FG02-91ER61100	Woods Hole Oceanographic Institution, MA (United States)	
	20:6528	DOE/ER/61100–1
FG02-91ER61206	State Univ. of New York, Old Westbury, NY (United States)	
	20:6529	DOE/ER/61206–3
FG02-93ER40764	Columbia Univ., New York, NY (United States)	
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	Lawrence Berkeley Lab., CA (United States)	
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	20:6700	LBL–34831
FG02-93ER81534	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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FG02-94ER40822	Michigan Univ., Ann Arbor, MI (United States)	
	20:6729	DOE/ER/40822–1
FG03-84ER53173	California Inst. of Tech., Pasadena, CA (United States)	
	20:6864	DOE/ER/53173–T3
	20:6865	DOE/ER/53173–T4
FG03-86ER53225	General Atomics, San Diego, CA (United States)	
	20:6898	GA-A–21807
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	20:6901	GA-A–21851
FG03-89ER51121	General Atomics, San Diego, CA (United States)	
	20:6898	GA-A–21807
	20:6901	GA-A–21851
FG03-91ER81105	USDOE Morgantown Energy Technology Center, WV (United States)	
	20:5075	DOE/METC–94/1002
FG03-91ER81229	Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center	
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FG03-92ER81442	USDOE Morgantown Energy Technology Center, WV (United States)	
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FG03-93ER40759	Stanford Linear Accelerator Center, Menlo Park, CA (United States)	
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FG03-93ER61728	California State Univ., Fullerton, CA (United States)	
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FG03-94ER54241	Texas Univ., Austin, TX (United States). Fusion Research Center	
	20:6867	DOE/ER/53266–48
FG05-80ET53088	Texas Univ., Austin, TX (United States). Inst. for Fusion Studies	
	20:6368	DOE/ET/53088–683
	20:6868	DOE/ET/53088–671
FG05-85ER13394	Virginia Univ., Charlottesville, VA (United States). Dept. of Physics	
	20:6809	DOE/ER/13394–T3
FG05-86DP70033	Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (United States). Management Systems Labs.	
	20:7070	DOE/DP/70033–T1
FG05-86ER40270	George Washington Univ., Washington, DC (United States). Center for Nuclear Studies	
	20:6760	DOE/ER/40270–55
FG05-86ER40272	Florida Univ., Gainesville, FL (United States). Dept. of Physics	
	20:6650	DOE/ER/40272–206
FG05-87ER40310	Texas A and M Univ., College Station, TX (United States)	
	20:6728	DOE/ER/40310–T3

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FG05-87ER40314	Tennessee Technological Univ., Cookeville, TN (United States). Dept. of Physics	
	20:6761	DOE/ER/40314–8
FG05-88ER53266	Texas Univ., Austin, TX (United States). Fusion Research Center	
	20:6867	DOE/ER/53266–48
FG05-90ER14100	Alabama Univ., University, AL (United States). Dept. of Mathematics	
	20:6337	DOE/ER/14100–T1
FG05-90ER40592	Lawrence Berkeley Lab., CA (United States)	
	20:6687	LBL–34831
FG05-91ER12115	Texas Univ., Austin, TX (United States)	
	20:6140	DOE/ER/12115–T1
FG05-91ER61250	Tennessee Univ., Knoxville, TN (United States)	
	20:6467	CONF-9305395–Summ.
FG06-87ER45292	Montana State Univ., Bozeman, MT (United States). Dept. of Physics	
	20:6289	DOE/ER/45292–15
FG06-90ER40561	Washington Univ., Seattle, WA (United States)	
	20:6652	DOE/ER/40561–170
	Washington Univ., Seattle, WA (United States). Inst. for Nuclear Theory	
	20:6685	DOE/ER/40561–168
	20:6776	DOE/ER/40561–167
	20:6777	DOE/ER/40561–169
FG06-91ER40637	Lawrence Berkeley Lab., CA (United States)	
	20:6703	LBL–34831
FG06-92ER14254	Department of Energy, Washington, DC (United States). Div. of Chemical Sciences	
	20:6283	DOE/ER/14254–2
FG06-92ER75776	Washington State Univ., Pullman, WA (United States)	
	20:6944	DOE/ER/75776–T1
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FG07-93ID13220	Idaho National Engineering Lab., Idaho Falls, ID (United States)	
	20:6179	DOE/ID/13220–T2
FG09-84ER13296	South Carolina Univ., Columbia, SC (United States). Dept. of Chemistry	
	20:6279	DOE/ER/13296–11
FG09-85ER13426	Georgia Univ., Athens, GA (United States). Complex Carbohydrate Research Center	
	20:6585	DOE/ER/13426–T3
FG09-87ER13811	Georgia Univ., Athens, GA (United States). Center for Computational Quantum Chemistry	
	20:6282	DOE/ER/13811–2
FG09-92SR18271	Selma Univ., AL (United States). Div. of Natural Sciences	
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FG21-88MC25031	USDOE Morgantown Energy Technology Center, WV (United States)	
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FG21-90MC27115	USDOE Morgantown Energy Technology Center, WV (United States)	
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FG21-91MC28072	USDOE Morgantown Energy Technology Center, WV (United States)	
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FG21-92MC29228	Lehigh Univ., Bethlehem, PA (United States)	
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	USDOE Morgantown Energy Technology Center, WV (United States)	
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FG21-92MC29254	USDOE Morgantown Energy Technology Center, WV (United States)	
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FG21-93MC29224	Missouri Univ., Rolla, MO (United States)	
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FG22-89PC89783	Oregon State Univ., Corvallis, OR (United States)	
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FG22-90PC90099	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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FG22-91PC91290	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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FG22-91PC91292	Grambling State Univ., LA (United States). Dept. of Chemistry	
	20:4985	DOE/PC/91292–T12
FG22-91PC91295	Michigan Univ., Ann Arbor, MI (United States)	
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FG22-91PC91297	Clarkson Univ., Potsdam, NY (United States). Dept. of Mechanical and Aeronautical Engineering	
	20:4986	DOE/PC/91297–T6
FG22-91PC91300	North Carolina Agricultural and Technical State Univ., Greensboro, NC (United States). Dept. of Chemical Engineering	
	20:4911	CONF-9406232–1
FG22-92PC92543	Pennsylvania State Univ., University Park, PA (United States)	
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FG22-92PC92546	Utah Univ., Salt Lake City, UT (United States). Dept. of Metallurgy and Metallurgical Engineering	
	20:4916	DOE/PC/92546–T8
FG22-93MT93008	Department of Energy, Morgantown, WV (United States). Morgantown Energy Technology Center	
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FG22-93PC93211	USDOE Pittsburgh Energy Technology Center, PA (United States)	
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FG22-93PC93215	Nevada Univ., Reno, NV (United States)	
	20:4901	DOE/PC/93215–T4
FG22-93PC93218	State Univ. of New York, Binghamton, NY (United States). Dept. of Chemistry	
	20:4902	DOE/PC/93218–3
FG22-93PC93222	Lehigh Univ., Bethlehem, PA (United States)	
	20:6284	DOE/PC/93222–4
FG22-94PC94205	Stanford Univ., CA (United States). High Temperature Gasdynamics Lab.	
	20:4988	DOE/PC/94205–T1
FG22-94PC94221	Lamar Univ., Beaumont, TX (United States). Dept. of Chemical Engineering	
	20:5692	DOE/PC/94221–T1
FG36-86SF16306	Colorado State Univ., Fort Collins, CO (United States). Solar Energy Applications Lab.	
	20:5576	DOE/SF/16306–44
FG49-93CE15600	Southern California Research Corp., San Rafael, CA (United States)	
	20:5011	DOE/CE/15600–T3
W-31-109-ENG-38	Argonne National Lab., IL (United States)	
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W-31109-ENG-38	Argonne National Lab., Idaho Falls, ID (United States)	
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	Argonne National Lab., IL (United States)	
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	Oak Ridge National Lab., TN (United States)	
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	Argonne National Lab., IL (United States). Physics Div.	
	20:6432	ANL/PHY/CP–84855
	20:6774	ANL/PHY/CP–84791
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CONF-9309228–		(Focus 93: site characterization and model validation; Las Vegas, NV (United States); 26-29 Sep 1993)			
13	20:5209	*See* SAND–93-7106C			
CONF-9310182–		(Workshop on beryllium for fusion applications; Karlsruhe (Germany); 4-5 Oct 1993)			
	20:6911	*See* KFK–5271			
CONF-9310276–		(8. wildland shrub and arid land restoration symposium; Las Vegas, NV (United States); 19-21 Oct 1993)			
12	20:6550	*See* EGG–11265-2035			
CONF-9310290–		(Workshop on postacceleration issues at the IsoSpin Laboratory (ISL); Berkeley, CA (United States); 27-29 Oct 1993)			
	20:6377	*See* LBL–35533			
CONF-9310375–		(Pollution prevention education for agri-chem dealers and farmers; Columbia, MO (United States); 5-6 Oct 1993)			
1	20:6943	OSTI; NTIS		DE95001727	
CONF-9310392–		(11. international school on nuclear physics, neutron physics and nuclear energy; Varna (Bulgaria); 4-11 Oct 1993)			
	20:6759	*See* INIS-mf–14421			
CONF-9311277–		(25. NIRS symposium; Chiba (Japan); 18-19 Nov 1993)			
	20:6612	*See* NIRS-M–97			
CONF-931174–		(Interregional seminar on research reactor centers: future prospects; Budapest (Hungary); 22-26 Nov 1993)			
	20:5861	*See* CEA-CONF–11812			
CONF-931188–		(17. annual training resources and data exchange conference: integrating training requirements and expectations; Indianapolis, IN (United States); 15-17 Nov 1993)			
4	20:5988	*See* WHC-SA–2210			
5	20:5987	*See* WHC-SA–2209			
CONF-931274–		(2. workshop on smart power/power-integrated circuits: technology and applications; Pasadena, CA (United States); 8-9 Dec 1993)			
	20:6360	*See* DOE/CH/10093–298			
CONF-9401108–		(38. international symposium on electron, ion and photon beam; New Orleans, LA (United States); 7 Jan 1994)			
1	20:6649	*See* UCRL-JC–115963			
CONF-940120–		(19. workshop on geothermal reservoir engineering; Stanford, CA (United States); 18-20 Jan 1994)			
6	20:5630	*See* LA-UR–94-2856			
CONF-9402121–		(2. steering conference relating to the 'agreement on the Implementation of Research at the Chrnobyl Center for International Research' beween CHECIR and JAERI; Tokyo (Japan); 22-25 Feb 1994)			
	20:5823	*See* JAERI-Conf–94-005			
CONF-940225–		(Waste management '94; Tucson, AZ (United States); 27 Feb - 3 mar 1994)			
120	20:5385	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017703	MF-2070
CONF-940277–		(Atmospheric radiation measurement science team meeting; Charleston, SC (United States); 28 Feb - 3 mar 1994)			
4	20:6344	*See* SAND–94-8597C			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-940285–		(New developments regarding the KT event and other catastrophes in earth history; Houston, TX (United States); 9-12 Feb 1994)			
1	20:6658	*See* SAND–93-2557C			
CONF-940301–		(207. spring national meeting of the American Chemical Society (ACS); San Diego, CA (United States); 13-18 Mar 1994)			
41	20:6149	OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616		TI94017659	
CONF-9403132–		(1994 ACM symposium on applied computing; Phoenix, AZ (United States); 6-8 Mar 1994)			
2	20:7058	*See* LBL–34780			
CONF-9403184–		(NATO Advanced Study Institute conference; Schluchsee (Germany); 7-18 Mar 1994)			
1	20:6470	*See* UCRL-JC–116021			
CONF-9403185–		(American Meterorlogical Society conference on boundary layers and turbulence; Charlotte, NC (United States); 27-31 Mar 1994)			
1	20:6639	*See* LA-UR–94-2956			
CONF-9403188–		(U.S./Japan energy conference; Maui, HI (United States); 7-9 Mar 1994)			
	20:5971	OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan		DE95730205	
CONF-9403189–		(1993 workshop on particle-material interactions for fusion; Tokai (Japan); 8-9 Mar 1994)			
	20:6955	*See* JAERI-Conf–94-004			
CONF-9404125–		(Haz Mat West spring meeting; Long Beach, CA (United States); 26-28 Apr 1994)			
2	20:6007	*See* UCRL-JC–116777			
CONF-940414–		(7. international symposium on gaseous dielectrics; Knoxville, TN (United States); 24-28 Apr 1994)			
6	20:6266	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001423	MF-407
CONF-940416–		(96. annual meeting of the American Ceramic Society (ACS); Indianapolis, IN (United States); 25-28 Apr 1994)			
31	20:6893	*See* ANL/CMT/CP–84818			
CONF-9404162–		(1994 chemical analysis by laser interrogation of proliferation effluents (CALIOPE ITR) interim technical review; Livermore, CA (United States); 26-28 Apr 1994)			
14	20:6471	*See* UCRL-JC–118476			
15	20:6546	*See* UCRL-JC–118477			
CONF-9404198–		(Workshop on atomic physics at high brilliance synchrotron sources; Argonne, IL (United States); 23-24 Apr 1994)			
	20:6808	*See* ANL/APS/TM–14			
CONF-9404210–		(Zeuthen workshop on elementary particle theory: Physics at LEP200 and beyond; Teupitz (Germany); 10-15 Apr 1994)			
	20:6723	*See* DESY–94-144			
CONF-940440–		(International conference on metallurgical coatings and thin films; San Diego, CA (United States); 25-29 Apr 1994)			
5	20:6178	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017768	MF-404
CONF-940492–		(Meeting on computing in high-energy physics; San Francisco, CA (United States); 21-27 Apr 1994)			
	20:6410	*See* LBL–35822			
CONF-9405132–		(14. international conference on few body problems in physics; Williamsburg, VA (United States); 26-31 May 1994)			
5	20:6768	*See* LA-UR–94-2132			
CONF-9405170–		(10. international conference on positron annihilation; Beijing (China); 23-29 May 1994)			
3	20:5487	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94014108	MF-404

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9405216–		(Neutrino '94: 16th international conference on neutrino physics and astrophysics; Eilat (Israel); 29 May - 3 jun 1994)			
	20:6727	*See* DESY–94-178			
CONF-9405256–		(Nordic seminar on emergency preparedness in nuclear accidents; Oslo (Norway); 4-6 May 1994)			
	20:6541	*See* NEI-NO–442			
	20:6609	*See* NEI-NO–440			
	20:6610	*See* NEI-NO–441			
	20:6611	*See* NEI-NO–443			
CONF-9405258–		(90. SEGJ conference; Tokyo (Japan); 25-27 May 1994)			
	20:5597	OSTI; NTIS; Available from The Society of Exploration Geophysicists of Japan, 2-18, Nakamagome 2-chome, Ota-ku, Tokyo, Japan		DE95722746	
CONF-9405264–		(Light element abundances; Elba (Italy); 23-28 May 1994)			
1	20:6656	*See* LA-UR–94-3937			
CONF-9405265–		(ASCE engineering mechanics conference; Boulder, CO (United States); 21-24 May 1994)			
1	20:6350	*See* LA-UR–94-3806			
CONF-9405266–		(Workshop on two-photon physics at LEP and HERA: status of data and models; Lund (Sweden); 26-28 May 1994)			
	20:6719	*See* DESY–94-136			
CONF-9405267–		(1994 Theoretical Advanced Study Institute conference; Boulder, CO (United States); 30 May - 23 jun 1994)			
1	20:6751	*See* BNL–61012			
CONF-940528–		(Incineration conference: 13th international symposium on thermal treatment technologies; Houston, TX (United States); 9-13 May 1994)			
7	20:6543	*See* SAND–94-8699C			
CONF-940529–		(185. Electrochemical Society meeting; San Francisco, CA (United States); 22-27 May 1994)			
23	20:5336	*See* WSRC-MS–94-0214P			
CONF-940580–		(11. international conference on plasma surface interactions in controlled fusion devices; Mito (Japan); 23-27 May 1994)			
22	20:6939	*See* UCRL-JC–115492			
23	20:6938	*See* UCRL-JC–115491			
CONF-940592–		(4. international colloquium on X-ray lasers; Williamsburg, VA (United States); 16-20 May 1994)			
10	20:6817	*See* UCRL-JC–117928			
CONF-940601–		(19. world gas congress; Milan (Italy); 6-9 Jun 1994)			
1	20:5532	OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616		TI94017664	
CONF-940613–		(1994 pressure vessels and piping conference; Minneapolis, MN (United States); 19-23 Jun 1994)			
25	20:5435	*See* UCRL-JC–117489			
CONF-9406131–		(Coal-fired power systems: advances in IGCC and PFBC review meeting; Morgantown, WV (United States); 21-23 Jun 1994)			
65	20:4941	*See* DOE/METC/C–94/7147			
CONF-9406232–		(Coal Research Contractors' review meeting; Pittsburgh, PA (United States); 8 Jun 1994)			
1	20:4911	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017564	MF-108
CONF-9406248–		(Workshop on quantum infrared physics; Paris (France); Jun 1994)			
5	20:6650	*See* DOE/ER/40272–206			
CONF-9406273–		(Tennessee international symposium on radiative corrections; Gatlinburg, TN (United States); 27 Jun - 1 jul 1994)			
	20:6726	*See* DESY–94-155			

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CONF-9406274–		(NATO Advanced Research workshop on hot hadronic matter: theory and experiment; Divonne-les-Bains (France); 27 Jun - 1 jul 1994)			
2	20:6795	*See* LBL–36250			
3	20:6790	*See* LA-UR–94-3967			
CONF-9406275–		(Conferencce on obscuration and aerosol research; Aberdeen, MD (United States); 2-5 Jun 1994)			
1	20:6527	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002258	MF-402
CONF-9406290–		(26. symposium on the interface: computer science and statistics; Triangle Park, NC (United States); 15-18 Jun 1994)			
1	20:6589	*See* UCRL-JC–117919			
CONF-9406291–		(5. conference on the intersections of particle and nuclear physics; Tampa, FL (United States); 1-6 Jun 1994)			
1	20:6789	*See* LA-UR–94-3744			
CONF-940630–		(11. topical meeting on the technology of fusion energy; New Orleans, LA (United States); 19-24 Jun 1994)			
51	20:6941	*See* UCRL-JC–117669			
52	20:6940	*See* UCRL-JC–116030			
CONF-940632–		(Annual meeting and exhibition of the Air and Waste Management Association; Cincinnati, OH (United States); 19-24 Jun 1994)			
27	20:5413	*See* FEMP–2321			
CONF-940681–		(Advanced accelerator concepts workshop; Lake Geneva, WI (United States); 13-18 Jun 1994)			
4	20:6415	*See* SLAC-PUB–6660			
CONF-940693–		(Conference on physics in collision; Tallahassee, FL (United States); 15-17 Jun 1994)			
5	20:6758	*See* SLAC-PUB–6620			
CONF-940701–		(Meeting on materials and mechanisms of superconductivity: high temperature superconductors; Grenoble (France); 4-9 Jul 1994)			
22	20:6859	*See* ANL/MSD/CP–84784			
CONF-9407103–		(International conference on accelerator-driven transmutation technologies and applications; Las Vegas, NV (United States); 25-28 Jul 1994)			
32	20:6933	*See* LBL–35960			
CONF-9407123–		(1994 review of progress in quantitative nondestructive evaluation conference; Snowmass, CO (United States); 31 Jul - 5 aug 1994)			
3	20:5474	*See* LA-UR–94-3713			
4	20:6351	*See* LA-UR–94-4014			
CONF-9407128–		(Workshop on future hadron facilities in the United States; Bloomington, IN (United States); 6-10 Jul 1994)			
Summs.	20:6370	*See* FNAL-TM–1907			
CONF-9407129–		(7. Marcel Grossman meeting on general relativity; Stanford, CA (United States); 24-29 Jul 1994)			
3	20:6661	*See* SLAC-PUB–6671			
CONF-9407135–		(QCD 94: nuclear physics B; Montpellier (France); 7-13 Jul 1994)			
	20:6724	*See* DESY–94-149			
CONF-940714–		(International meeting on synchrotron radiation instrumentation; Stony Brook, NY (United States); 18-22 Jul 1994)			
41	20:6419	*See* ANL/XFD/CP–82942			
42	20:6420	*See* ANL/XFD/CP–82943			
43	20:6421	*See* ANL/XFD/CP–82944			
44	20:6422	*See* ANL/XFD/CP–82945			
45	20:6423	*See* ANL/XFD/CP–82946			
CONF-9407155–		(Workshop on phytoremediation research needs; Santa Rosa, CA (United States); 24-26 Jul 1994)			
Summ.	20:6547	*See* DOE/EM–0224			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-940722–		(27. international conference on high energy physics; Glasgow (United Kingdom); 21-27 Jul 1994)			
32	20:6755	*See* FNAL/C–94/331-E			
33	20:6756	*See* FNAL/C–94/339-E			
34	20:6752	*See* FNAL/C–93/334-E			
35	20:6732	*See* FNAL/C–94/306-E			
36	20:6750	*See* BNL–60981			
CONF-940723–		(Annual meeting of the Society of Photo-Optical Instrumentation Engineers; San Diego, CA (United States); 24-29 Jul 1994)			
32	20:6457	*See* UCRL-JC–116456			
34	20:6366	*See* UCRL-JC–117859			
CONF-940731–		(2. international conference on computer simulation of radiation effects; Santa Barbara, CA (United States); 24-29 Jul 1994)			
3	20:6856	*See* LBL–35679			
CONF-940790–		(10. annual waste testing and quality assurance symposium; Arlington, VA (United States); 11-15 Jul 1994)			
3	20:5414	*See* FEMP–2336			
CONF-940793–		(27. annual International Metallographic Society meeting; Montreal (Canada); 24-27 Jul 1994)			
2	20:5334	*See* WSRC-MS–94-0149			
CONF-940812–		(29. intersociety energy conversion engineering conference; Monterey, CA (United States); 7-12 Aug 1994)			
4	20:5735	*See* LA-UR–94-1688			
19	20:5533	OSTI; Institute of Gas Technology, 3424 South State Str., Chicago, IL 60616		TI94017665	
CONF-9408125–		(17. international LINAC conference; Tsukuba (Japan); 21-26 Aug 1994)			
43	20:6411	*See* LBL–36232			
44	20:6413	*See* SLAC-PUB–6624			
CONF-9408127–		(45. Scottish Universities summer school in physics; Fife (United Kingdom); 7-20 Aug 1994)			
5	20:6932	*See* LA-UR–94-3945			
CONF-9408140–		(1994 RELAP-5 internal users seminar; Baltimore, MD (United States); 29 Aug - 1 sep 1994)			
1	20:5963	*See* WAPD-T–3038			
CONF-9408144–		(Conference on environmental regulations for federal facilities and government contractors; San Diego, CA (United States); 14 Aug 1994)			
1	20:6008	*See* UCRL-JC–118025			
CONF-940815–		(International nuclear and hazardous waste management conference; Atlanta, GA (United States); 14-18 Aug 1994)			
79	20:5430	*See* PNL-SA–23411			
83	20:5431	*See* PNL-SA–24403			
CONF-940816–		(Meeting of the Division of Particles and Fields of the American Physical Society; Albuquerque, NM (United States); 2-6 Aug 1994)			
53	20:6708	*See* SLAC-PUB–6618			
54	20:6748	*See* SLAC-PUB–6601			
55	20:6430	*See* SLAC-PUB–6714			
56	20:6442	*See* FNAL/C–94/335-E			
57	20:6655	*See* LA-UR–94-3766			
58	20:6753	*See* FNAL/C–94/282-E			
59	20:6733	*See* FNAL/C–94/329-E			
60	20:6443	*See* FNAL/C–94/352-E			
61	20:6734	*See* FNAL/C–94/330-E			
62	20:6441	*See* FNAL/C–94/318-E			
63	20:6730	*See* FNAL/C–94/289-E			
64	20:6440	*See* FNAL/C–94/312			
65	20:6731	*See* FNAL/C–94/294-E			
66	20:6446	*See* FNAL/C–94/375-E			
67	20:6754	*See* FNAL/C–94/328-E			
Pt.1	20:6735	*See* FNAL/C–94/365-E			

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CONF-9408169–		(American Council for Energy-Efficient Economy (ACEEE) summer conference; Asilomar, CA (United States); 28 Aug - 3 sep 1994)			
1	20:6056	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017708	MF-1321
CONF-940817–		(World congress in particle technology; Denver, CO (United States); 17-20 Aug 1994)			
2	20:5092	*See* WAPD-T–3020			
CONF-9408173–		(19. session of the international seminars on planetary emergencies; Erice (Italy); 19-24 Aug 1994)			
2	20:6171	*See* LA-UR–94-3867			
CONF-9408176–		(ISPP workshop on the theory of fusion plasmas; Varenna (Italy); 22-26 Aug 1994)			
	20:6881	*See* LRP–503/94			
3	20:6870	*See* GA-A–21811			
4	20:6899	*See* GA-A–21821			
CONF-9408180–		(4. KINR international school on nuclear physics; Kiev (Russian Federation); 29 Aug - 7 sep 1994)			
2	20:6770	*See* LBL–36206			
CONF-9408195–		(Practical robotic interstellar flight conference; New York, NY (United States); 28 Aug - 1 sep 1994)			
1	20:5506	*See* FNAL/C–94/355-E			
CONF-9408196–		(FEL '94: nuclear instrument methods; Stanford, CA (United States); 21-26 Aug 1994)			
1	20:6362	*See* LA-UR–94-3985			
CONF-9408197–		(Flows of granular materials in complex geometries meeting; Albuquerque, NM (United States); 15-16 Aug 1994)			
	20:4963	*See* SAND–94-2732			
CONF-9408200–		(EPRI conference on the effect of coal quality on boiler performance; Charleston, SC (United States); 17-19 Aug 1994)			
1	20:4992	*See* SAND–94-8761C			
CONF-940829–		(14. international colloquium on magnetic films and surfaces; Duesseldorf (Germany); 29 Aug - 2 sep 1994)			
1	20:6242	*See* BNL–60869			
CONF-940843–		(18. European symposium on fusion technology; Karlsruhe (Germany); 22-26 Aug 1994)			
12	20:6896	*See* GA-A–21789			
CONF-940847–		(Conference on the application of high magnetic fields; Cambridge, MA (United States); 8-12 Aug 1994)			
4	20:6857	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018044	MF-404
CONF-940853–		(Summer meeting of the American Institute of Chemical Engineers; Denver, CO (United States); 14-17 Aug 1994)			
12	20:4995	*See* BNL–61080			
CONF-940873–		(11. office information technology conference; Chicago, IL (United States); 23-25 Aug 1994)			
3	20:7075	*See* WHC-SA–2594			
CONF-940883–		(Fuel cells '94; Morgantown, WV (United States); 17-19 Aug 1994)			
	20:6081	*See* DOE/METC–94/1010			
CONF-940888–		(Physics with large gamma ray decector arrays conference; Berkley, CA (United States); 2-6 Aug 1994)			
1	20:6774	*See* ANL/PHY/CP–84791			
CONF-940893–		(Summer conference on energy efficiency in buildings; Monterey, CA (United States); 29 Aug - 3 sep 1994)			
17	20:6136	*See* PNL-SA–24187			
CONF-9409103–		(International symposia on high energy spin physics and polarization phenomena in nuclear physics; Bloomington, IN (United States); 15-22 Sep 1994)			
6	20:6796	*See* LBL–36299			
7	20:6788	*See* LA-UR–94-3727			

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8	20:6745	*See* LA-UR–94-3728			
9	20:6709	*See* ANL-HEP-CP–94-66			
CONF-9409112–		(1. international workshop on fuzzy logic and intelligent technologies in nuclear science (FLINS-1); Mol (Belgium); 14-16 Sep 1994)			
1	20:5471	*See* LA-UR–94-3116			
CONF-9409134–		(Conference on high energy physics: hadron structure; Kosice (Slovakia); 19-23 Sep 1994)			
1	20:6736	*See* FNAL/C–94/374-E			
CONF-9409168–		(Coal liquefaction and gas conversion contractors' review conference; Pittsburgh, PA (United States); 7-8 Sep 1994)			
10	20:4909	*See* PNL-SA–24684			
CONF-9409177–		(Optical Society of America conference on extreme ultraviolet lithography; Monterey, CA (United States); 19-21 Sep 1994)			
6	20:6375	*See* LA-UR–94-3785			
CONF-9409178–		(American Chemical Society meeting on industrial and engineering chemistry; Atlanta, GA (United States); 19-21 Sep 1994)			
2	20:5216	*See* UCRL-JC–117575			
5	20:6120	*See* LA-UR–94-3313			
8	20:5130	*See* ANL/CMT/CP–82509			
CONF-9409182–		(Fluctuation phenomena: disorder and nonlinearity conference; Madrid (Spain); 26-30 Sep 1994)			
2	20:6676	*See* LA-UR–94-3852			
CONF-9409231–		(NEA workshop on binding models-organics; Bad Zurach (Switzerland); 14-16 Sep 1994)			
1	20:5180	*See* LA-UR–94-3303			
CONF-9409238–		(Workshop on rock mechanics; Rockville, MD (United States); 19-20 Sep 1994)			
1	20:5212	*See* SAND–94-2243C			
CONF-9409239–		(29. Zakopane school of physics; Zakopane (Poland); 5-14 Sep 1994)			
2	20:6432	*See* ANL/PHY/CP–84855			
CONF-9409241–		(NEEDS '94; Los Alamos, NM (United States); 12-16 Sep 1994)			
4	20:6675	*See* LA-UR–94-3816			
CONF-9409242–		(CORINNE 2: international conference on multiparticles correlation and particle production in nucleus-nucleus collisions; Nantes (France); 5-9 Sep 1994)			
2	20:6769	*See* LBL–36165			
CONF-9409257–		(24. international symposium on multiparticle dynamics; Vietri sul Mare (Italy); 12-19 Sep 1994)			
1	20:6749	*See* SLAC-PUB–6707			
CONF-9409258–		(Workshop on nonlinear dynamics in particle accelerators: theory and experiments; Arcidosso (Italy); 4-9 Sep 1994)			
1	20:6383	*See* SLAC-PUB–6727			
2	20:6379	*See* SLAC-PUB–6650			
CONF-9409259–		(Electromagnetic probes and the structure of hadrons and nuclei; Erice (Italy); 15-23 Sep 1994)			
1	20:6771	*See* SLAC-PUB–6729			
CONF-9409260–		(4. Euro-food tox meeting; No City Given (Poland); 12-16 Sep 1994)			
1	20:6630	*See* UCRL-JC–117823			
CONF-9409261–		(ICSM '94: IEEE international conference on software engineering; Victoria (Canada); 21-23 Sep 1994)			
1	20:5478	*See* UCRL-JC–117935			
CONF-9409264–		(Low-energy antiproton physics; Bled (Slovenia); 12-17 Sep 1994)			
1	20:6657	*See* LA-UR–94-3953			
CONF-9409265–		(European symposium on satellite remote sensing; Rome (Italy); 26-30 Sep 1994)			
1	20:5552	*See* EGG–11265-1075			

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CONF-9409256–		(1994 American meat industry research conference; San Francisco, CA (United States); 29 Sep - 1 oct 1994)			
1	20:6600	*See* SAND–94-2149C			
CONF-9409267–		(American Society of Mechanical Engineers fluids engineering summer meeting; Hilton Head, SC (United States); 13 Sep 1994 - 18 sep 1995)			
1	20:6346	*See* WAPD-T–3063			
CONF-9409268–		(5. international conference on calorimetry in high energy physics; Upton, NY (United States); 25 Sep - 1 oct 1994)			
1	20:6445	*See* FNAL/C–94/372			
2	20:6448	*See* FNAL/C–94/398			
CONF-9409270–		(3. school on astrofundamental physics; Erice (Italy); Sep 1994)			
1	20:6652	*See* DOE/ER/40561–170			
CONF-940933–		(15. international conference on plasma physics and controlled nuclear fusion research; Seville (Spain); 26 Sep - 1 oct 1994)			
16	20:6942	*See* UCRL-JC–118496			
17	20:6892	*See* UCRL-JC–117113			
18	20:6876	*See* LA-UR–94-3664			
19	20:6900	*See* GA-A–21840			
20	20:6872	*See* GA-A–21847			
21	20:6901	*See* GA-A–21851			
22	20:6897	*See* GA-A–21804			
23	20:6898	*See* GA-A–21807			
CONF-940976–		(1. International workshop on accelerator-based neutron sources for boron neutron capture therapy; Jackson, WY (United States); 11-14 Sep 1994)			
2	20:6594	*See* LBL–35540			
CONF-940981–		(21. international symposium on compound semiconductors; San Diego, CA (United States); 18-22 Sep 1994)			
4	20:6252	*See* LBL–35434			
CONF-940994–		(15. international conference on plasma physics and controlled nuclear fusion research; Madrid (Spain); 26 Sep - 1 oct 1994)			
3	20:6869	*See* GA-A–21799			
CONF-941001–		(41. annual American Vacuum Society symposium; Denver, CO (United States); 24-28 Oct 1994)			
8	20:6177	*See* ANL/MSD/CP–84783			
CONF-941006–		(Annual conference of the Optical Society of America and exhibit; Boston, MA (United States); 30 Oct - 4 nov 1994)			
3	20:6659	*See* SAND–94-1186C			
CONF-941011–		(3. international conference on containment design and operation; Toronto (Canada); 19-21 Oct 1994)			
2	20:5888	*See* LA-UR–94-2751			
3	20:5959	*See* SAND–93-2686C			
4	20:5880	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94019321	MF-406
5	20:5960	*See* SAND–93-2698C			
CONF-941013–		(Applied superconductivity conference; Boston, MA (United States); 16-21 Oct 1994)			
1	20:6225	*See* LA-UR–94-3789			
12	20:6226	*See* LA-UR–94-3850			
13	20:6224	*See* LA-UR–94-1390			
14	20:6861	*See* LA-UR–94-3725			
15	20:5965	*See* LA-UR–94-3655			
16	20:6858	*See* ANL/MSD/CP–83118			
17	20:6424	*See* BNL–60991			
CONF-9410131–		(1994 hypervelocity impact symposium; Santa Fe, NM (United States); 16-20 Oct 1994)			
6	20:6819	*See* SAND–93-3866C			
11	20:6660	*See* SAND–94-1816C			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-941014–		(Topical conference on the critical state in superconductors; Honolulu, HI (United States); 24-26 Oct 1994)			
1	20:6217	*See* BNL–60962			
CONF-9410140–		(17. national computer security conference; Baltimore, MD (United States); 11-14 Oct 1994)			
2	20:7063	*See* UCRL-JC–116899			
CONF-9410156–		(28. annual Asilomar conference on signals, systems, and computers; Pacific Grove, CA (United States); 31 Oct - 2 nov 1994)			
3	20:6593	*See* LA-UR–94-3978			
CONF-9410163–		(19. international conference on infrared and millimeter waves; Sendai (Japan); 17-21 Oct 1994)			
1	20:6895	*See* GA-A–21741			
CONF-9410165–		(Neutron scattering; Sendai (Japan); 11-14 Oct 1994)			
9	20:6240	*See* ANL/MSD/CP–84837			
CONF-941017–		(4. conference on radiation protection and dosimetry; Orlando, FL (United States); 24-27 Oct 1994)			
1	20:6620	*See* WSRC-MS–94-0404			
4	20:6615	*See* PNL-SA–24011			
CONF-9410170–		(1. European solid oxide fuel cell forum: engineering, systems, applications; Lucerne (Switzerland); 3-7 Oct 1994)			
2	20:6077	*See* ANL/CMT/CP–84099			
CONF-9410193–		(International conference on environmental control of combustion processes; Honolulu, HI (United States); 7-10 Oct 1994)			
1	20:6355	*See* SAND–94-8556			
CONF-9410197–		(Mid-America conference on intelligent systems; Overland Park, KS (United States); 27 Oct 1994)			
2	20:6312	*See* KCP–613-5500			
CONF-9410216–		(22. transactions of the water reactor safety information meeting; Bethesda, MD (United States); 24-26 Oct 1994)			
	20:5950	*See* NUREG/CP–0139			
CONF-9410218–		(Pulsed radio frequency sources for linear colliders; Long Island, NY (United States); 2-7 Oct 1994)			
3	20:6417	*See* SLAC-PUB–6689			
4	20:6407	*See* LA-UR–94-4061			
5	20:6376	*See* LA-UR–94-3974			
CONF-9410219–		(Beam instrumentation workshop; Vancouver (Canada); 2-6 Oct 1994)			
18	20:6429	*See* LBL–36279			
19	20:6416	*See* SLAC-PUB–6675			
20	20:6408	*See* LA-UR–94-4118			
21	20:6386	*See* FNAL/C–94/333			
22	20:6405	*See* LA-UR–94-3350			
CONF-9410229–		(4. international conference on charged particle optics; Tsukuba (Japan); 3-6 Oct 1994)			
2	20:6380	*See* FNAL/C–94/356-E			
CONF-9410233–		(Workshop on ion source issues relevant to a pulsed spallation neutron source; Berkeley, CA (United States); 24-26 Oct 1994)			
Pt.2	20:6412	*See* LBL–36347			
CONF-9410237–		(1994 Geographic Information Systems/Land Information Systems (GIS/LIS); Phoenix, AZ (United States); 25-27 Oct 1994)			
1	20:7074	*See* SAND–94-2764C			
CONF-9410241–		(Solar and electric vehicles '94; Providence, RI (United States); 3-5 Oct 1994)			
1	20:6144	*See* ANL/ES/CP–84138			
CONF-9410253–		(Applications in manufacturing and services industries conference; Kansas City, MO (United States); 27-28 Oct 1994)			
1	20:6313	*See* KCP–613-5502			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-9410254–		(Nuclear explosives code developers conference (NECDC); Las Vegas, NV (United States); 27 Oct 1994)			
1	20:6304	*See* SAND–94-2639C			
CONF-9410255–		(10. international symposium on atherosclerosis; Montreal (Canada); 10-14 Oct 1994)			
1	20:6588	*See* LBL–36154			
CONF-9410256–		(Society of Automotive Engineers' convergence '94; Detroit, MI (United States); 18 Oct 1994)			
1	20:6143	*See* UCRL-JC–116894			
CONF-9410258–		(14. conference on charged particle accelerators; Protvino (Russian Federation); 25-27 Oct 1994)			
1	20:6369	*See* FNAL/C–94/360			
CONF-9410259–		(Remote temperature sensing workshop; Cleveland, OH (United States); 27-28 Oct 1994)			
1	20:6141	*See* EGG–11265-3011			
CONF-9410262–		(Coalbed methane utilization conference; Katowice (Poland); 5-7 Oct 1994)			
1	20:5043	*See* DOE/MC/26026–95/C0404			
CONF-941054–		(8. annual Idaho National Engineering Laboratory (INEL) computing symposium; Idaho Falls, ID (United States); 4-7 Oct 1994)			
1	20:5732	*See* ANL/IFR/CP–82836			
CONF-941061–		(Nuclear science symposium: medical imaging conference; Norfolk, VA (United States); 30 Oct - 5 nov 1994)			
8	20:6414	*See* SLAC-PUB–6656			
9	20:6444	*See* FNAL/C–94/370			
10	20:6433	*See* BNL–61058			
11	20:6387	*See* FNAL/C–94/399			
CONF-941075–		(18. international symposium on the scientific basis for nuclear waste management; Kyoto (Japan); 23-27 Oct 1994)			
5	20:5215	*See* UCRL-JC–116435			
CONF-941102–		(Winter meeting of the American Nuclear Society; Washington, DC (United States); 13-18 Nov 1994)			
22	20:5889	*See* LA-UR–94-2820			
27	20:5890	*See* LA-UR–94-3143			
35	20:5185	*See* LA-UR–94-3825			
36	20:5182	*See* LA-UR–94-3724			
37	20:5230	*See* WHC-SA–2709			
CONF-9411116–		(U.S. Department of Energy (DOE) human genome program contractor- grantee workshop; Santa Fe, NM (United States); 13-17 Nov 1994)			
	20:6586	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002230	MF-408
CONF-9411120–		(4. Tamura symposium on accelerator physics; Austin, TX (United States); 14-16 Nov 1994)			
2	20:6367	*See* BNL–60963			
CONF-9411135–		(ASPENWORLD 94; Boston, MA (United States); 6-9 Nov 1994)			
2	20:6297	*See* LA-UR–94-3705			
1-Rev.1	20:5337	*See* WSRC-MS–94-0246-Rev.1			
CONF-9411144–		(Optical sensing for environmental and process monitoring; McLean, VA (United States); 7-10 Nov 1994)			
3	20:6276	*See* SAND–94-2817C			
CONF-9411151–		(Technology 2004; Washington, DC (United States); 8-10 Nov 1994)			
1	20:6361	*See* KCP–613-5515			
CONF-9411152–		(International Atomic Energy Agency (IAEA) technical committee meeting on drivers for inertial confinement fusion; Paris (France); 14-18 Nov 1994)			
1	20:6935	*See* SAND–94-1419C			
CONF-9411153–		(Development status of modular high temperature reactors and their future role; Petten (Netherlands); 28-30 Nov 1994)			
1	20:5727	*See* GA-A–21894			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
2	20:5728	*See* GA-A-21924			
3	20:5726	*See* GA-A-21827			
4	20:5729	*See* GA-A-21925			
CONF-9411154--		(Fall meeting of the American Ceramic Society; Columbus, OH (United States); 14-18 Nov 1994)			
1	20:5344	*See* WSRC-MS-94-0569			
CONF-9411155--		(1994 Luxembourg international symposium on the rehabilitation of military sites and demilitarization of explosive ordance; Kirchberg (Luxembourg); 14-18 Nov 1994)			
1	20:6285	*See* LA-UR-94-3803			
CONF-9411156--		(International Atomic Energy Agency (IAEA) technical committee meeting; Vienna (Austria); 21-25 Nov 1994)			
1	20:5186	*See* LA-UR-94-3865			
CONF-9411157--		(Semiarid hydrology conference; Tucson, AZ (United States); 1-3 Nov 1994)			
1	20:6558	*See* LA-UR-94-3833			
CONF-9411158--		(1994 U.S. Army Edgewood Research conference on development and Engineering (ERDEC); Edgewood, MD (United States); 15-18 Nov 1994)			
1	20:6526	*See* LA-UR-94-3736			
CONF-9411159--		(Asilomar/signals, systems and computers; Pacific Grove, CA (United States); 1 Nov 1994)			
1	20:6477	*See* LA-UR-94-3977			
CONF-941118--		(Supercomputing '94 meeting; Digital media and electronic publishing conference; Washington, DC (United States); Leeds (United Kingdom); 14-18 Nov 1994; 6-8 dec 1994)			
9	20:7073	*See* LA-UR-94-3835			
CONF-941119--		(16. annual international conference of the Engineering in Medicine and Biology Society; Baltimore, MD (United States); 3-6 Nov 1994)			
1	20:6597	*See* SAND-94-2707C			
CONF-941128--		(Annual meeting of the American Institute of Chemical Engineers; San Francisco, CA (United States); 13-18 Nov 1994)			
1	20:5756	*See* LA-UR-94-3208			
3	20:6810	*See* ANL/MCS/CP-84764			
CONF-941129--		(13. international conference on the application of accelerators in research and industry; Denton, TX (United States); 7-10 Nov 1994)			
10	20:6815	*See* UCRL-JC-117932			
CONF-941141--		(Physics, safety and applications of pulse reactors; Washington, DC (United States); 13-17 Nov 1994)			
3	20:5871	*See* SAND-94-0761C			
CONF-941142--		(American Society of Mechanical Engineers' winter annual meeting; Chicago, IL (United States); 9-11 Nov 1994)			
25	20:6109	*See* UCRL-JC-117938			
26	20:6343	*See* SAND-94-2264C			
CONF-941144--		(1994 fall meeting of the Materials Research Society (MRS); Boston, MA (United States); 28 Nov - 2 dec 1994)			
2	20:6190	*See* LA-UR-94-4084			
3	20:6230	*See* LA-UR-94-4052			
4	20:6293	*See* LA-UR-94-4071			
5	20:6352	*See* LA-UR-94-4082			
6	20:6189	*See* LA-UR-94-4081			
7	20:6251	*See* LA-UR-94-4051			
8	20:6406	*See* LA-UR-94-4040			
9	20:6229	*See* LA-UR-94-3966			
10	20:6188	*See* LA-UR-94-3956			
11	20:6250	*See* LA-UR-94-4043			
12	20:6286	*See* LA-UR-94-3999			
13	20:6228	*See* LA-UR-94-3935			
14	20:6828	*See* LA-UR-94-3872			
15	20:6227	*See* LA-UR-94-3930			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
16	20:6187	*See* LA-UR–94-3726			
17	20:6385	*See* ANL/IPNS/CP–84859			
18	20:6176	*See* ANL/MSD/CP–83328			
CONF-941148–		(ANS meeting on environmental aspects of decommissioning, decontamination, and/or environmental restoration at nuclear and mixed waste facilities; Washington, DC (United States); 13-17 Nov 1994)			
4	20:5415	*See* FEMP–2338			
5	20:5473	*See* LA-UR–94-3691			
CONF-941176–		(7. international symposium on superconductivity; Kita Kiyushu (Japan); 8-11 Nov 1994)			
1	20:5964	*See* ANL/ET/CP–83629			
CONF-941207–		(Spent nuclear fuel meeting: challenges and initiatives; Salt Lake City, UT (United States); 14-16 Dec 1994)			
1	20:5341	*See* WSRC-MS–94-0467			
2	20:5339	*See* WSRC-MS–94-0444			
3	20:5129	*See* WSRC-MS–94-0493			
4	20:5340	*See* WSRC-MS–94-0446			
5	20:5472	*See* LA-UR–94-3287			
6	20:5338	*See* WSRC-MS–94-0320			
12	20:5343	*See* WSRC-MS–94-0564			
15	20:5342	*See* WSRC-MS–94-0558			
17	20:5116	*See* WHC-SA–2508			
CONF-941210–		(Power generation conference; Orlando, FL (United States); 7-9 Dec 1994)			
1	20:5661	*See* DOE/MC/29309–95/C0408			
CONF-941227–		(5. symposium on current issues related to nuclear power plant structure, equipment and piping; Orlando, FL (United States); 14-16 Dec 1994)			
3	20:5878	*See* BNL-NUREG–60983			
CONF-941240–		(International conference on professionalism and excellence in R&D; London (United Kingdom); 3-6 Dec 1994)			
1	20:6020	*See* SAND–94-2699C			
CONF-941243–		(Supercomputing '94 meeting; Digital media and electronic publishing conference; Washington, DC (United States); Leeds (United Kingdom); 14-18 Nov 1994; 6-8 dec 1994)			
1	20:7073	*See* LA-UR–94-3835			
CONF-941244–		(System prioritization method workshop; Carlsbad, NM (United States); 8-9 Dec 1994)			
1	20:5133	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003738	MF-2000
2-Rev.1	20:5134	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003737	MF-2000
Summ.	20:5135	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003736	MF-2020
CONF-941246–		(2. annual EM cost management conference; San Francisco, CA (United States); 5-9 Dec 1994)			
1	20:5416	*See* FEMP–2390			
CONF-950110–		(12. symposium on space nuclear power and propulsion; Albuquerque, NM (United States); 8-12 Jan 1995)			
3	20:5737	*See* SAND–94-2322C			
15	20:5184	*See* LA-UR–94-3784			
16	20:5736	*See* LA-UR–94-3723			
CONF-950151–		(NATO (ASI)/monitoring a comprehensive test ban treaty; Algrave (Portugal); 23 Jan - 2 feb 1995)			
1	20:6173	*See* LA-UR–94-3871			
2	20:6524	*See* LA-UR–94-3939			
3	20:6525	*See* LA-UR–94-3940			
CONF-950201–		(Annual meeting and exhibition of the Minerals, Metals and Materials Society; Las Vegas, NV (United States); 12-16 Feb 1995)			
1	20:6249	*See* LA-UR–94-3958			

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CONF-950212--		(7. SIAM conference on parallel processing for scientific computing; San Francisco, CA (United States); 15-17 Feb 1995)			
1	20:7057	*See* LA-UR--94-3301			
2	20:7061	*See* SAND--94-2444C			
3	20:6345	*See* UCRL-JC--118604			
4	20:7060	*See* SAND--94-2420C			
CONF-950216--		(Waste management '95; Tucson, AZ (United States); 26 Feb - 2 mar 1995)			
1	20:5227	*See* WHC-SA--2624			
CONF-950221--		(3. international working conference on fractals in the natural and applied sciences; Marseille (France); 7-10 Feb 1995)			
1	20:6654	*See* LA-UR--94-2077			
CONF-950225--		(Geoenvironment 2000 meeting; Baton Rouge, LA (United States); 22-24 Feb 1995)			
1	20:5434	*See* UCRL-JC--115345			
CONF-950232--		(6. American Nuclear Society meeting on robotics and remote systems; Monterey, CA (United States); 5-10 Feb 1995)			
1	20:5335	*See* WSRC-MS--94-0211			
2	20:5433	*See* SAND--94-2394C			
4	20:6305	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000687	
6	20:6307	*See* DOE/MC/30362--95/C0405			
7	20:6306	*See* DOE/MC/29115--95/C0403			
8	20:5229	*See* WHC-SA--2669			
10	20:5228	*See* WHC-SA--2627			
11	20:5224	*See* WHC-SA--2447			
12	20:5225	*See* WHC-SA--2448			
CONF-950233--		(Internet Society symposium; San Diego, CA (United States); 16-27 Feb 1995)			
1	20:7056	*See* LA-UR--94-2790			
CONF-950240--		(International modal analysis conference; Nashville, TN (United States); 13-16 Feb 1995)			
1	20:6314	*See* SAND--94-1624C			
2	20:6319	*See* SAND--94-2681C			
3	20:6248	*See* LA-UR--94-3470			
4	20:6320	*See* SAND--94-2702C			
CONF-950241--		(5. international symposium on chemical oxidation; Nashville, TN (United States); 15-17 Feb 1995)			
1	20:6569	*See* SAND--94-8732C			
CONF-950242--		(Symposium on applied computing (SAC '95); Nashville, TN (United States); 26-28 Feb 1995)			
1	20:7064	*See* UCRL-JC--118448			
CONF-950246--		(Microphysics of surfaces: nanoscale processing meeting; Santa Fe, NM (United States); 9-11 Feb 1995)			
1	20:6243	*See* BNL--60904			
CONF-950247--		(21. annual conference on explosives and blasting techniques and 11th annual symposium on explosives and blasting research; Nashville, TN (United States); 5-9 Feb 1995)			
1	20:6476	*See* LA-UR--94-3490			
CONF-950248--		(American Aeronautics Society/American Institute of Aeronautics and Astronautics Space flight mechanics meeting; Albuquerque, NM (United States); 13-15 Feb 1995)			
1	20:6318	*See* SAND--94-2402C			
CONF-950256--		(Society of Automotive Engineers international congress and exposition; Detroit, MI (United States); 27 Feb - 2 mar 1995)			
1	20:6147	*See* UCRL-JC--117918			
2	20:6145	*See* UCRL-JC--116834			
CONF-950257--		(International conference on automation, robotics, and artificial intelligence; Montreaux (Switzerland); 7-10 Feb 1995)			
1	20:6587	*See* LA-UR--94-3972			

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CONF-950258–		(1995 Institute of Electrical and Electronics Engineers (IEEE) aerospace applications conference; Snowmass, CO (United States); 13-17 Feb 1995)			
1	20:7062	*See* SAND–94-3112C			
CONF-950304–		(National Association of Corrosion Engineers corrosion conference; Orlando, FL (United States); 20-25 Mar 1995)			
2	20:6216	*See* WSRC-MS–94-0535			
3	20:5226	*See* WHC-SA–2539			
4	20:5025	*See* WSRC-MS–94-0529			
CONF-950336–		(American Society of Mechanical Engineers/Japanese Society of Mechanical Engineers/Japan Solar Energy Society international solar energy conference; Maui, HI (United States); 19-24 Mar 1995)			
1	20:5822	*See* WSRC-MS–94-0359			
2	20:5571	*See* SAND–94-1839C			
3	20:5569	*See* NREL/TP–471-7019			
4	20:5568	*See* NREL/TP–471-7017			
5	20:6239	*See* SAND–94-8415C			
6	20:5570	*See* SAND–94-0657C			
7	20:5592	*See* SAND–94-2638C			
8	20:6034	*See* NREL/TP–472-7293			
9	20:5588	*See* NREL/TP–471-7294			
10	20:5589	*See* NREL/TP–472-7295			
11	20:5574	*See* SAND–94-2909C			
12	20:5573	*See* SAND–94-2776C			
13	20:5593	*See* SAND–94-2682C			
14	20:5555	*See* SAND–94-2910C			
15	20:5572	*See* SAND–94-2555C			
CONF-950344–		(InterPack '95: international electronic packaging conference; Maui, HI (United States); 26-30 Mar 1995)			
1	20:6363	*See* SAND–94-1112C			
2	20:6364	*See* SAND–94-1982C			
3	20:6315	*See* SAND–94-2215C			
4	20:6365	*See* SAND–94-2749C			
CONF-950364–		(1994 ASPRS/ACSM technical program; Bethesda, MD (United States); 2 Mar 1995)			
1	20:6947	*See* LA-UR–94-3653			
CONF-950393–		(NACE international annual corrosion conference; Orlando, FL (United States); 26-28 Mar 1995)			
1	20:5345	*See* WSRC-MS–94-0582			
CRIE-R–					
01	20:6359	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-5-1, Ote-machi, Chiyoda-ku, Tokyo, Japan		DE95723047	
93003	20:7066	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730178	
93009	20:6463	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730179	
93015	20:7067	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730180	
94001	20:7068	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730185	
94002	20:7069	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730186	
CRIE-T–					
91045	20:6036	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730177	
CRIE-U–					
93048	20:6575	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730181	

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CRIE-Y–					
93008	20:5982	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730182	
93011	20:5983	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730183	
93012	20:6125	OSTI; NTIS; Available from Central Research Institute of Electric Power Industry, 1-6-1, Otemachi, Chiyoda-ku, Tokyo, Japan		DE95730184	
CRN–					
94-09	20:6438	OSTI; NTIS (US Sales Only); INIS		DE95611193	
CTH-R–					
92-12	20:5648	*See* NUTEK-VIND–94-11			
DESY–					
93-016	20:6711	OSTI; NTIS (US Sales Only); INIS		DE95733431	
94-077	20:6712	OSTI; NTIS (US Sales Only); INIS		DE95725967	
94-114	20:6713	OSTI; NTIS (US Sales Only); INIS		DE95725968	
94-120	20:6714	OSTI; NTIS (US Sales Only); INIS		DE95725959	
94-122	20:6645	OSTI; NTIS (US Sales Only); INIS		DE95725986	
94-124	20:6715	OSTI; NTIS (US Sales Only); INIS		DE95725958	
94-125	20:6716	OSTI; NTIS (US Sales Only); INIS		DE95725960	
94-126	20:6679	OSTI; NTIS (US Sales Only); INIS		DE95725955	
94-127	20:6717	OSTI; NTIS (US Sales Only); INIS		DE95725665	
94-129	20:6680	OSTI; NTIS (US Sales Only); INIS		DE95725965	
94-130	20:6439	OSTI; NTIS (US Sales Only); INIS		DE95725961	
94-131	20:6718	OSTI; NTIS (US Sales Only); INIS		DE95725957	
94-134	20:6681	OSTI; NTIS (US Sales Only); INIS		DE95725966	
94-135	20:6667	OSTI; NTIS (US Sales Only); INIS		DE95725956	
94-136	20:6719	OSTI; NTIS (US Sales Only); INIS		DE95725663	
94-138	20:6720	OSTI; NTIS (US Sales Only); INIS		DE95732221	
94-139	20:6721	OSTI; NTIS (US Sales Only); INIS		DE95732177	
94-140	20:6722	OSTI; NTIS (US Sales Only); INIS		DE95725659	
94-141	20:6646	OSTI; NTIS (US Sales Only); INIS		DE95725662	
94-142	20:6682	OSTI; NTIS (US Sales Only); INIS		DE95725661	
94-144	20:6723	OSTI; NTIS (US Sales Only); INIS		DE95725660	
94-149	20:6724	OSTI; NTIS (US Sales Only); INIS		DE95725567	
94-150	20:6668	OSTI; NTIS (US Sales Only); INIS		DE95725566	
94-151	20:6683	OSTI; NTIS (US Sales Only); INIS		DE95725564	
94-153	20:6725	OSTI; NTIS (US Sales Only); INIS		DE95731948	
94-155	20:6726	OSTI; NTIS (US Sales Only); INIS		DE95731933	
94-157	20:6669	OSTI; NTIS (US Sales Only); INIS		DE95731949	
94-178	20:6727	OSTI; NTIS (US Sales Only); INIS		DE95731368	
DFPD–					
94/TH-27	20:6712	*See* DESY–94-077			
DLR-FB–					
93-54	20:6336	OSTI; NTIS (US Sales Only)		DE95733253	
DOE–					
0227-2-Rev.1	20:5111	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003991	MF-2000
DOE-HDBK–					
1079-94	20:6603	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003577	MF-500
1081-94	20:5407	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003576	MF-500
DOE-STD–					
3013-94	20:5112	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004199	MF-500
DOE/AL/62350–					
101	20:5138	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003918	MF-2000
116	20:5388	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003908	MF-2010
132-Rev.1	20:5389	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003886	MF-2010
134	20:5355	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003911	MF-2010
147	20:5356	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003882	MF-512
149	20:5357	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003890	MF-2010
150	20:5358	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003885	MF-512
153	20:5139	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003916	MF-2000
159	20:5390	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003891	MF-2010

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
167	20:5140	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003912	MF-2000
168	20:5141	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003913	MF-2000
169-Rev.1	20:5391	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003914	MF-2010
170	20:5392	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003883	MF-512
174	20:5393	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003884	MF-512
5-Rev.1	20:5386	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003917	MF-2000
56-Rev.5	20:5136	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003910	MF-2000
64-Rev.1	20:5354	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003889	MF-2010
76-Rev.6	20:5137	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003915	MF-2000
79-Rev.1	20:5387	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003909	MF-2000
T4	20:5142	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003924	MF-2000
T5	20:5394	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003925	MF-2000
T6	20:5143	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003926	MF-2010
DOE/BC/14950–					
4	20:5009	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000114	PC-122
DOE/BC/14958–					
8	20:5010	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000113	PC-122
DOE/BP–					
2451	20:5968	*See* DOE/EIS–0204			
DOE/CE/15529–					
T1	20:6111	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003830	MF-1400
DOE/CE/15554–					
T2	20:6112	OSTI; NTIS; GPO Dep.	E 1.99:	DE95005124	MF-1400
DOE/CE/15600–					
T3	20:5011	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004113	MF-123
DOE/CE/15612–					
T2	20:5538	OSTI; NTIS; GPO Dep.	E 1.99:	DE95005112	MF-1414
DOE/CE/15974–					
T9	20:6244	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004297	MF-1407
DOE/CE/23810–					
45	20:6113	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003733	MF-1600
DOE/CE/50343–					
2	20:6078	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004215	MF-1500
DOE/CE/90049–					
T1	20:6137	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003831	MF-1501
DOE/CH/10093–					
251	20:6092	OSTI; NTIS; GPO Dep.	E 1.99:	DE94000225	PC-1416
298	20:6360	OSTI; NTIS; GPO Dep.	E 1.99:	DE94006867	MF-406
332	20:6093	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004710	MF-1600
350	20:5575	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000296	MF-1600
DOE/DP/70033–					
T1	20:7070	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017792	MF-700
DOE/EA–					
0347-Rev.2	20:5395	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003887	MF-2000
0464-Rev.5	20:5396	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003888	MF-2000
0952	20:6126	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004417	MF-620
0958	20:5990	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004412	MF-600
0965	20:6013	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004416	MF-620

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
0978	20:5150	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004414	MF-602
0999	20:5548	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004411	MF-603
1001	20:5991	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004415	MF-630
DOE/EE–					
0033	20:6169	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003982	MF-1504
DOE/EH–					
0426	20:6576	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003291	MF-600
0430	20:5397	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003788	MF-600
231011-Rev.I/0194	20:5992	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016529	MF-630
DOE/EIA–					
0035(94/11)	20:6037	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003486	MF-950
0035(94/12)	20:6038	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004483	MF-950
0095(93)	20:6057	OSTI; NTIS; GPO; INIS; GPO Dep.	E 1.99:	DE95004720	MF-950
0109(94/12)	20:5016	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004666	MF-950
0130(94/12)	20:6048	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95003872	MF-950
0204(94/05)	20:6066	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE95003447	MF-950
0226(94/11)	20:6039	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE95003494	MF-950
0249(94)	20:6011	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004329	MF-950
0370(94)	20:5017	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004719	MF-950
0376(92)	20:5984	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004173	MF-950
0512(91)	20:6114	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004721	MF-950
0520(94/12)	20:5018	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004481	MF-950
0538(94/95-12)	20:6050	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004746	MF-950
0538(94/95-13)	20:6040	OSTI; NTIS; GPO Dep.	E 1.99:	DE95005090	MF-950
0538(94/95-9)	20:6049	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003984	MF-950
0543(94/3Q)	20:5985	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004665	MF-950
0587	20:6067	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004482	MF-950
TR/0575	20:5007	OSTI; NTIS; GPO; GPO Dep.	E 1.99:	DE95004722	MF-950
DOE/EIS–					
0082-S	20:5151	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004413	MF-630
0195D-Vol.1	20:5398	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE95004461	MF-630
0195D-Vol.2	20:5399	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE95004462	MF-630
0195D-Vol.3	20:5400	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE95004463	MF-630
0195D-Vol.4	20:5401	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE95004464	MF-630
0204	20:5968	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002673	MF-630
DOE/EM–					
0089T-Rev.2	20:6267	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004428	MF-2020
0197	20:5402	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004245	MF-2000
0198	20:5403	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004244	MF-2000
0201	20:5404	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003293	MF-2010
0202	20:5993	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003294	MF-2010
0216	20:5405	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003756	MF-2000
0223-Vol.1	20:5994	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004505	MF-2000
0223-Vol.2	20:5995	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004506	MF-2000
0224	20:6547	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95006076	MF-2070
0226	20:5406	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004984	MF-2000
DOE/ER–					
0614P	20:6662	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94013641	MF-414
0632	20:7014	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95005329	MF-400
DOE/ER/02504–					
341	20:6663	OSTI; NTIS; GPO Dep.	E 1.99:	DE94014071	MF-414
DOE/ER/12115–					
T1	20:6140	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004375	MF-406
DOE/ER/13296–					
11	20:6279	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004180	MF-401
DOE/ER/13394–					
T3	20:6809	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94014162	MF-411
DOE/ER/13406–					
9	20:6280	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004436	MF-401

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/ER/13426–					
T3	20:6585	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003099	MF-408
DOE/ER/13631–					
T2	20:5556	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004405	MF-408
DOE/ER/13775–					
6	20:6281	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003732	MF-401
DOE/ER/13811–					
2	20:6282	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004551	MF-401
DOE/ER/14100–					
T1	20:6337	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004213	MF-405
DOE/ER/14254–					
2	20:6283	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003834	MF-401
DOE/ER/20019–					
T1	20:6583	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004179	MF-408
DOE/ER/40103–					
T6	20:6664	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004214	MF-414
DOE/ER/40270–					
55	20:6760	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004377	MF-413
DOE/ER/40272–					
206	20:6650	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003342	MF-414
DOE/ER/40310–					
T3	20:6728	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003828	MF-413
DOE/ER/40314–					
8	20:6761	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003701	MF-413
DOE/ER/40317–					
13	20:6651	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004300	MF-412
DOE/ER/40448–					
T1	20:6684	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004341	MF-413
DOE/ER/40561–					
167	20:6776	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004354	MF-413
168	20:6685	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004355	MF-414
169	20:6777	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004356	MF-413
170	20:6652	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004357	MF-414
DOE/ER/40764–					
3	20:6778	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004114	MF-414
DOE/ER/40822–					
1	20:6729	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003624	MF-414
DOE/ER/45292–					
15	20:6289	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003836	MF-404
DOE/ER/53173–					
T3	20:6864	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004177	MF-420
T4	20:6865	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004178	MF-420
DOE/ER/53198–					
251	20:6866	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004467	MF-420
DOE/ER/53266–					
48	20:6867	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003345	MF-427
DOE/ER/60561–					
10	20:6590	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004305	MF-408
DOE/ER/61100–					
1	20:6528	OSTI; NTIS; GPO Dep.	E 1.99:	DE94013784	MF-402
DOE/ER/61206–					
3	20:6529	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004435	MF-402
DOE/ER/61728–					
T1	20:6530	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003607	MF-402; MF-401
DOE/ER/75776–					
T1	20:6944	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004295	MF-400
T2	20:6945	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004296	MF-400
DOE/ET/10815–					
228	20:6073	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003594	MF-112
DOE/ET/53088–					
671	20:6868	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003222	MF-420
683	20:6368	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004402	MF-421
DOE/EV/10449–					
T2	20:6622	OSTI; NTIS			MF-402
DOE/FE–					
0322	20:5019	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004504	MF-122; MF-132
DOE/HR–					
0083	20:7071	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003967	MF-900
0098	20:6946	OSTI (Free of Charge)		TI95004808	PC-900

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DOE/ID–					
10456	20:6300	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95003975	MF-1030
12082(93)	20:5408	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002023	MF-502
DOE/ID/12735–					
T33	20:6074	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003832	MF-101
DOE/ID/13220–					
T2	20:6179	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003827	MF-2000
DOE/IG–					
0001/95	20:6949	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003981	MF-900
0005	20:6014	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003983	MF-960
0359	20:6127	OSTI (Free of Charge)		TI95004812	PC-960
0360	20:6950	OSTI (Free of Charge)		TI95004811	PC-960
0362	20:6951	OSTI (Free of Charge)		TI95004810	PC-960
0363	20:6952	OSTI (Free of Charge)		TI95004809	PC-960
DOE/LLW–					
205	20:5152	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003309	MF-2000
DOE/MC/11076–					
3828	20:4890	OSTI; NTIS; GPO Dep.	E 1.99:	DE94012266	PC-108
DOE/MC/21023–					
3926	20:5659	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000019	MF-103
DOE/MC/23165–					
3885	20:5660	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000010	PC-111
DOE/MC/24116–					
3928	20:4891	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000021	MF-109
DOE/MC/26026–					
3947	20:5030	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004304	MF-132
95/C0404	20:5043	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004219	MF-132
DOE/MC/26372–					
3863	20:4892	OSTI; NTIS; GPO Dep.	E 1.99:	DE94004144	PC-106
DOE/MC/27229–					
3948	20:4979	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004303	MF-103
DOE/MC/27233–					
3919	20:4893	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000003	PC-109
DOE/MC/27240–					
T5	20:4894	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003620	MF-109
DOE/MC/28060–					
3856	20:4930	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017582	MF-113
3949	20:4931	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004302	MF-107
DOE/MC/28139–					
3929	20:5031	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000022	MF-131
DOE/MC/29115–					
95/C0403	20:6306	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001589	MF-2060
DOE/MC/29116–					
3858	20:5409	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017588	MF-2070
DOE/MC/29224–					
3931	20:6079	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000024	MF-110
DOE/MC/29228–					
3936	20:5543	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000029	MF-113; MF-106
DOE/MC/29254–					
3933	20:4980	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000026	MF-103
DOE/MC/29309–					
95/C0408	20:5661	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004233	MF-111
DOE/MC/29467–					
3939	20:6548	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000033	MF-2000
DOE/MC/30251–					
3938	20:4932	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000032	MF-105
DOE/MC/30362–					
95/C0405	20:6307	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001590	MF-2060
DOE/METC–					
94/1010	20:6081	OSTI; NTIS; GPO Dep.	E 1.99:	DE94012285	MF-110
DOE/METC/C–					
94/7147	20:4941	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003384	MF-103; MF-106

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/MI/10270–					
T3	20:6641	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004338	MF-900
T5	20:6642	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004340	MF-900
DOE/NE/37957–					
T1	20:5881	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003598	MF-520
T2	20:5882	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004261	MF-520
DOE/NE/44139–					
55	20:5153	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004254	PC-510
64	20:5154	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004252	PC-510
69	20:5155	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004253	PC-510
DOE/NV–					
374	20:6604	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004398	MF-702
DOE/NV/11417–					
5	20:5156	OSTI; NTIS; GPO Dep.	E 1.99:	DE95005122	MF-814
DOE/OR–					
01-1273/V1-D1	20:5157	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002066	MF-2010
DOE/OR/21443–					
T2	20:5359	OSTI; NTIS; GPO Dep.	E 1.99:	DE94011971	MF-402
DOE/OSTI–					
3406-(Suppl.3)(Add.3)	20:5158	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE93015389	PC-814
DOE/PC/79672–					
T9	20:6075	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004308	MF-112
DOE/PC/89651–					
T15	20:5688	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002388	PC-105
DOE/PC/89659–					
T15	20:4984	OSTI; NTIS; GPO Dep.	E 1.99:	DE94009024	MF-105
DOE/PC/89783–					
T12	20:4897	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018038	PC-108
DOE/PC/90044–					
T2	20:4898	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001146	PC-109
DOE/PC/91050–					
T8-Vol.3	20:4899	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004325	MF-108
DOE/PC/91155–					
T7	20:5666	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004316	MF-112
DOE/PC/91162–					
T11	20:5667	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004318	MF-104
DOE/PC/91164–					
T10	20:4885	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017134	MF-102
DOE/PC/91292–					
T12	20:4985	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003565	MF-104
DOE/PC/91295–					
T12	20:4942	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003572	MF-107
DOE/PC/91297–					
T6	20:4986	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017554	MF-117
DOE/PC/91344–					
T9	20:4943	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004319	MF-105
DOE/PC/92114–					
T4	20:5544	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004317	MF-125
DOE/PC/92116–					
T3	20:5545	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004323	MF-108
T4	20:5546	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004306	MF-108
DOE/PC/92117–					
T10	20:5547	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004315	MF-108
DOE/PC/92190–					
T5	20:4987	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004321	MF-105
DOE/PC/92208–					
T7	20:4900	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004312	MF-102
DOE/PC/92521–					
T179	20:4886	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003555	MF-102
DOE/PC/92543–					
T8	20:4887	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003571	MF-102
DOE/PC/92546–					
T8	20:4916	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004311	MF-102
DOE/PC/92578–					
T3	20:4958	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003559	MF-117
DOE/PC/93051–					
T3	20:4917	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004320	MF-113
DOE/PC/93215–					
T4	20:4901	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004309	MF-102

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/PC/93218–					
3	20:4902	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017379	MF-113
DOE/PC/93222–					
4	20:6284	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004324	MF-113
DOE/PC/93251–					
T1-Vol.2	20:5689	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016051	PC-105
T3-Vol.1	20:5690	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018832	PC-105
T3-Vol.2	20:5691	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018833	PC-105
DOE/PC/94110–					
T1	20:6354	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004314	MF-104
DOE/PC/94205–					
T1	20:4988	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003522	MF-104
DOE/PC/94221–					
T1	20:5692	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004307	MF-106
DOE/RL–					
89-12-Rev.2-Draft-A	20:5360	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003266	MF-2010
89-28-Rev.2	20:5159	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004360	MF-2000
94-106	20:6308	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004145	MF-2000
94-29	20:5160	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003269	MF-2010
DOE/RW–					
0449	20:5161	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003292	
DOE/SF/16306–					
44	20:5576	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004299	MF-1302
DOE/SR/18271–					
T1	20:6549	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003819	MF-702
DPW–					
55-15-2	20:5862	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004912	MF-700
55-15-3	20:5093	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004913	MF-700
55-24-5	20:5863	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018612	MF-700
56-167	20:5094	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004914	MF-700
56-241	20:5864	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018525	MF-700
56-276	20:5865	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018524	MF-700
56-311	20:5095	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018523	MF-700
56-353	20:5866	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017912	MF-700
56-419	20:5410	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018522	MF-700
56-421	20:5867	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018521	MF-700
DTH-IMSOR-TR–					
1993-10	20:6128	OSTI; NTIS		DE95723831	
1993-12	20:5970	OSTI; NTIS		DE95723832	
DTU-LV-MEDD–					
246	20:6094	OSTI; NTIS		DE95723852	
265	20:5577	OSTI; NTIS		DE95723843	
269	20:5578	OSTI; NTIS		DE95723841	
270	20:5579	OSTI; NTIS		DE95723863	
EEV–					
94-01	20:5634	OSTI; NTIS		DE95723849	
EGG–					
11265-1075	20:5552	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003619	MF-708
11265-2035	20:6550	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004166	MF-702
11265-3011	20:6141	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003625	MF-706
11265-5025	20:5468	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004165	MF-706
2716-Vol.3	20:5953	*See* NUREG/CR–6116-Vol.3			
EGG-WM–					
10774-Rev.2	20:5113	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002039	MF-2000
10877-Rev.1	20:5114	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002022	MF-2000
ENRESA–					
05/94	20:6638	OSTI; NTIS		DE95721639	
06/94	20:5162	OSTI; NTIS; INIS		DE95721638	
07/94	20:5163	OSTI; NTIS; INIS		DE95721636	
EPA–					
520/1-87-023	20:6605	OSTI; NTIS; GPO Dep.	E 1.99:	DE95005270	
ES/ER/TM–					
120/V3	20:7072	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001386	MF-2000

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
136	20:5412	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003903	MF-2000
98	20:5411	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017745	MF-2000
ESD–					
4195	20:6542	*See* ORNL/CDIAC–65			
ESTSC–					
000138CY00101	20:7015	ESTSC			
000142IBMPC04	20:7016	ESTSC			
000219I600001	20:7017	ESTSC			
000219MNFRM04	20:7018	ESTSC			
000228CY00100	20:7019	ESTSC			
000273CY00101	20:7020	ESTSC			
000653I309000	20:7021	ESTSC			
000704D0VAX00	20:7022	ESTSC			
000713IBMPC00	20:7023	ESTSC			
000716IBMPC01	20:7024	ESTSC			
000716IBMPC02	20:7025	ESTSC			
000716IBMPC03	20:7026	ESTSC			
000716IBMPC04	20:7027	ESTSC			
000716IBMPC05	20:7028	ESTSC			
000716IBMPC06	20:7029	ESTSC			
000716IBMPC07	20:7030	ESTSC			
000716IBMPC08	20:7031	ESTSC			
000721SPARC00	20:7032	ESTSC			
000729IB48600	20:7033	ESTSC			
000737IBMPC00	20:7034	ESTSC			
000743IBMPC00	20:7035	ESTSC			
000750IBMPC00	20:7036	ESTSC			
000751IBMPC00	20:7037	ESTSC			
000752SPARC00	20:7038	ESTSC			
000757D078000	20:7039	ESTSC			
000758C650000	20:7040	ESTSC			
000759IBMPC00	20:7041	ESTSC			
000760IBMPC00	20:7042	ESTSC			
000761IBMPC00	20:7043	ESTSC			
000762IBMPC00	20:7044	ESTSC			
000763I036000	20:7045	ESTSC			
000765C660000	20:7046	ESTSC			
000769C760000	20:7047	ESTSC			
000770IBMPC00	20:5074	ESTSC			
000771IBMPC00	20:7048	ESTSC			
000772IBMPC00	20:7049	ESTSC			
000773IBMPC00	20:4903	ESTSC			
000775IBMPC00	20:7050	ESTSC			
000776IB48600	20:7051	ESTSC			
000777I037000	20:7052	ESTSC			
000779D0VAX00	20:7053	ESTSC			
ESTSC/NRC/R–					
000719IBMPC00	20:7054	ESTSC			
ETDE/DE-mf–					
95725527	20:4959	OSTI; NTIS (US Sales Only)		DE95725527	
95726049	20:6058	OSTI; NTIS (US Sales Only)		DE95726049	
95726054	20:6059	OSTI; NTIS (US Sales Only)		DE95726054	
95726395	20:5527	OSTI; NTIS (US Sales Only)		DE95726395	
95726722	20:6531	OSTI; NTIS (US Sales Only)		DE95726722	
95726784	20:6041	OSTI; NTIS (US Sales Only)		DE95726784	
95726788	20:6060	OSTI; NTIS (US Sales Only)		DE95726788	
95726792	20:5668	OSTI; NTIS (US Sales Only)		DE95726792	
95726793	20:5669	OSTI; NTIS (US Sales Only)		DE95726793	
95726859	20:6623	OSTI; NTIS (US Sales Only)		DE95726859	
95726879	20:6624	OSTI; NTIS (US Sales Only)		DE95726879	
95726883	20:6348	OSTI; NTIS (US Sales Only)		DE95726883	
95726890	20:5580	OSTI; NTIS (US Sales Only)		DE95726890	
95726909	20:6309	OSTI; NTIS (US Sales Only)		DE95726909	
95726910	20:6310	OSTI; NTIS (US Sales Only)		DE95726910	
95726947	20:5562	OSTI; NTIS (US Sales Only)		DE95726947	
95726966	20:6625	OSTI; NTIS (US Sales Only)		DE95726966	
95726970	20:6115	OSTI; NTIS (US Sales Only)		DE95726970	
95726971	20:6116	OSTI; NTIS (US Sales Only)		DE95726971	
95726973	20:5567	OSTI; NTIS (US Sales Only)		DE95726973	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
95726974	20:6532	OSTI; NTIS (US Sales Only)		DE95726974	
95726982	20:5535	OSTI; NTIS (US Sales Only)		DE95726982	
95726987	20:5635	OSTI; NTIS (US Sales Only)		DE95726987	
95726996	20:6626	OSTI; NTIS (US Sales Only)		DE95726996	
95726997	20:6220	OSTI; NTIS (US Sales Only)		DE95726997	
95733213	20:6095	OSTI; NTIS (US Sales Only)		DE95733213	
95733233	20:6096	OSTI; NTIS (US Sales Only)		DE95733233	
95733236	20:6042	OSTI; NTIS (US Sales Only)		DE95733236	
95733242	20:6061	OSTI; NTIS (US Sales Only)		DE95733242	
95733277	20:6062	OSTI; NTIS (US Sales Only)		DE95733277	
95733278	20:6633	OSTI; NTIS (US Sales Only)		DE95733278	
95733282	20:6117	OSTI; NTIS (US Sales Only)		DE95733282	
95733287	20:5979	OSTI; NTIS (US Sales Only)		DE95733287	
95733291	20:6129	OSTI; NTIS (US Sales Only)		DE95733291	
95733292	20:5528	OSTI; NTIS (US Sales Only)		DE95733292	
95733293	20:5581	OSTI; NTIS (US Sales Only)		DE95733293	
95733294	20:6268	OSTI; NTIS (US Sales Only)		DE95733294	
95733298	20:6063	OSTI; NTIS (US Sales Only)		DE95733298	
95733301	20:5974	OSTI; NTIS (US Sales Only)		DE95733301	
95733310	20:5000	OSTI; NTIS (US Sales Only)		DE95733310	
95733314	20:6148	OSTI; NTIS (US Sales Only)		DE95733314	
95733315	20:5636	OSTI; NTIS (US Sales Only)		DE95733315	
95733316	20:5557	OSTI; NTIS (US Sales Only)		DE95733316	
95733335	20:5001	OSTI; NTIS (US Sales Only)		DE95733335	
95733337	20:6269	OSTI; NTIS (US Sales Only)		DE95733337	
95733344	20:5026	OSTI; NTIS (US Sales Only)		DE95733344	
95733346	20:6051	OSTI; NTIS (US Sales Only)		DE95733346	
95733348	20:5563	OSTI; NTIS (US Sales Only)		DE95733348	
95733349	20:5976	OSTI; NTIS (US Sales Only)		DE95733349	
95733375	20:5977	OSTI; NTIS (US Sales Only)		DE95733375	
95733377	20:5078	OSTI; NTIS (US Sales Only)		DE95733377	
95733378	20:5079	OSTI; NTIS (US Sales Only)		DE95733378	
95733379	20:6097	OSTI; NTIS (US Sales Only)		DE95733379	
95733381	20:6301	OSTI; NTIS (US Sales Only)		DE95733381	
95733384	20:6098	OSTI; NTIS (US Sales Only)		DE95733384	
95733388	20:5564	OSTI; NTIS (US Sales Only)		DE95733388	
95733392	20:6634	OSTI; NTIS (US Sales Only)		DE95733392	
95733393	20:5590	OSTI; NTIS (US Sales Only)		DE95733393	
95733399	20:6221	OSTI; NTIS (US Sales Only)		DE95733399	
95733403	20:6180	OSTI; NTIS (US Sales Only)		DE95733403	
95733405	20:5529	OSTI; NTIS (US Sales Only)		DE95733405	
95733415	20:4960	OSTI; NTIS (US Sales Only)		DE95733415	
95733420	20:5996	OSTI; NTIS (US Sales Only)		DE95733420	
95733422	20:6338	OSTI; NTIS (US Sales Only)		DE95733422	
95733455	20:6245	OSTI; NTIS (US Sales Only)		DE95733455	
95733457	20:6065	OSTI; NTIS (US Sales Only)		DE95733457	
95733464	20:6627	OSTI; NTIS (US Sales Only)		DE95733464	
95733473	20:4961	OSTI; NTIS (US Sales Only)		DE95733473	
ETDE/JP-mf–					
95723030	20:5997	OSTI; NTIS; Available from Science and Technology Agency, 2-1, Kasumigaseki 2-chome, Chiyoda-ku, Tokyo, Japan		DE95723030	
95723113	20:5623	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723113	
95729915	20:6099	OSTI; NTIS; Available from Okumura Corp., 2-2-2, Matsuzaki-cho, Abeno-ku, Osaka, Japan		DE95729915	
95730104	20:6222	OSTI; NTIS; Available from National Institute for Research in Inorganic Materials, 1-1, Namiki, Tsukuba, Ibaraki, Japan		DE95730104	
95730105	20:6647	OSTI; NTIS; Available from National Institute for Research in Inorganic Materials, 1-1, Namiki, Tsukuba, Ibaraki, Japan		DE95730105	
95730106	20:6223	OSTI; NTIS; Available from National Institute for Research in Inorganic Materials, 1-1, Namiki, Tsukuba, Ibaraki, Japan		DE95730106	
95730143	20:5998	OSTI; NTIS; Available from Mitsubishi Research Institute Inc., 3-6, Otemachi 2-chome, Chiyoda-ku, Tokyo, Japan		DE95730143	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
ETDE/JP-mf–					
95730256	20:5624	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95730256	
95730258	20:5594	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730258	
95730259	20:5595	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730259	
95730260	20:5596	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730260	
FEMP–					
2321	20:5413	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003488	MF-702
2336	20:5414	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018443	MF-2000
2338	20:5415	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003487	MF-700
2390	20:5416	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003966	MF-700
FEMP/SUB–					
058	20:5417	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018442	MF-2010
FFU–					
93-3	20:5978	OSTI; NTIS (US Sales Only)		DE95733354	
FNAL-TM–					
1906	20:6449	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003388	MF-414
1907	20:6370	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004513	MF-414
1908	20:6388	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003386	MF-414
1909	20:6371	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003387	MF-414
1910	20:6389	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004351	MF-414
1913	20:6450	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003747	MF-414
FNAL/C–					
93/334-E	20:6752	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003497	MF-414
94/282-E	20:6753	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003498	MF-414
94/289-E	20:6730	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003745	MF-414
94/294-E	20:6731	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004239	MF-414
94/306-E	20:6732	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004234	MF-414
94/312	20:6440	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003746	MF-414
94/318-E	20:6441	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003742	MF-414
94/328-E	20:6754	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004240	MF-414
94/329-E	20:6733	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003495	MF-414
94/330-E	20:6734	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003382	MF-414
94/331-E	20:6755	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003381	MF-414
94/333	20:6386	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003379	MF-414
94/335-E	20:6442	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003500	MF-414
94/339-E	20:6756	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003496	MF-414
94/352-E	20:6443	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003380	MF-414
94/355-E	20:5506	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003502	MF-414
94/356-E	20:6380	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004236	MF-414
94/360	20:6369	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003501	MF-414
94/365-E	20:6735	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004580	MF-414
94/370	20:6444	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003744	MF-414
94/372	20:6445	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003739	MF-414
94/374-E	20:6736	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003748	MF-414
94/375-E	20:6446	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004235	MF-414
94/377-E	20:6447	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003743	MF-414
94/398	20:6448	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004237	MF-414
94/399	20:6387	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004353	MF-414
FRCEA-TH–					
410	20:6349	OSTI; NTIS (US Sales Only); INIS		DE95611124	
FRCR–					
451	20:6867	*See* DOE/ER/53266–48			
GA-A–					
21741	20:6895	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94016584	MF-420
21789	20:6896	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003741	MF-420
21799	20:6869	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003878	MF-420
21804	20:6897	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003940	MF-420
21807	20:6898	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003877	MF-420

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
21811	20:6870	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003383	MF-420
21821	20:6899	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003880	MF-420
21827	20:5726	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003503	MF-522
21839	20:6871	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004249	PC-420
21840	20:6900	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003879	MF-420
21847	20:6872	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003941	MF-420
21851	20:6901	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003942	MF-420
21894	20:5727	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003378	MF-522
21924	20:5728	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003490	MF-400
21925	20:5729	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003492	MF-400
GAO/RCED–					
93-153	20:5738	OSTI; NTIS; INIS		DE95004465	
GKSS–					
94/E/6	20:6551	OSTI; NTIS (US Sales Only); INIS		DE95726118	
GRI–					
94/0037	20:6552	OSTI; Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631		TI95004389	
94/0226	20:6553	OSTI; Gas Research Institute, 8600 West Bryn Mawr Ave., Chicago, IL 60631; NTIS; GPO Dep.	E 1.99:	DE95004390	
GRS–					
95	20:5883	OSTI; NTIS (US Sales Only); INIS		DE95726933	
GRS-F–					
2/1993	20:5884	OSTI; NTIS (US Sales Only); INIS		DE95725644	
GRS-F-BL–					
1+2/1994	20:5885	OSTI; NTIS (US Sales Only); INIS		DE95725641	
GSF–					
41/93	20:6628	OSTI; NTIS (US Sales Only); INIS		DE95726903	
GSI–					
94-55(prepr.)	20:6737	OSTI; NTIS (US Sales Only); INIS		DE95725941	
94-57(prepr.)	20:6813	OSTI; NTIS (US Sales Only); INIS		DE95725942	
HAN–					
85392	20:5090	OSTI; NTIS; GPO Dep.	E 1.99:	DE94015116	MF-500
HDC–					
1131	20:5096	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004915	MF-700
1162	20:5097	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004916	MF-700
1216	20:5098	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004917	MF-700
1232	20:5099	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004918	MF-700
1253	20:5100	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004919	MF-700
1278	20:5101	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004920	MF-700
1284	20:5102	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004921	MF-700
1291	20:5103	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004922	MF-700
1304	20:5104	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004923	MF-700
HEP-LAT–					
9407009	20:6679	*See* DESY–94-126			
HEP-PH–					
9405281	20:6712	*See* DESY–94-077			
9407359	20:6713	*See* DESY–94-114			
9408340	20:6722	*See* DESY–94-140			
9408377	20:6724	*See* DESY–94-149			
HEP-TH–					
9407086	20:6667	*See* DESY–94-135			
9407162	20:6680	*See* DESY–94-129			
HIFAN–					
666	20:6933	*See* LBL–35960			
HU-Berlin-IEP–					
94/11	20:6679	*See* DESY–94-126			
94/13	20:6683	*See* DESY–94-151			
HUB-IEP–					
94/12	20:6668	*See* DESY–94-150			
HW–					
19974	20:5868	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018600	MF-500
23646	20:5755	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003235	MF-701
31767	20:5088	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003377	MF-711
45747	20:5164	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003375	MF-603
70711	20:5817	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018226	MF-520
74723	20:5418	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016847	MF-500
76115	20:5869	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018251	MF-520
78883	20:5870	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016402	MF-500
79463	20:5730	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018250	MF-520
84104	20:5886	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018252	MF-500

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IAEA-CN–					
60/A-4-I-2	20:6901	*See* GA-A–21851			
60/A-5-I-1	20:6898	*See* GA-A–21807			
60/A3/5-P-11	20:6869	*See* GA-A–21799			
60/D-D-II-8	20:6872	*See* GA-A–21847			
60/F-P-2	20:6897	*See* GA-A–21804			
IAEA-TECDOC–					
763	20:5694	OSTI; NTIS (US Sales Only); INIS		DE95611137	
ICF–					
0001	20:5419	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001294	MF-2000
IEE-SR–					
250	20:6130	OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan		DE95723045	
252	20:6118	OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan		DE95723044	
255	20:6087	OSTI; NTIS; Available from The Institute of Energy Economics, Dai 10 Mori Biru, 18-1, Toranomon 1-chome, Minato-ku, Tokyo, Japan		DE95730202	
IFP–					
41371	20:5014	OSTI; NTIS (US Sales Only)		DE95729626	
41398	20:5008	OSTI; NTIS (US Sales Only)		DE95729625	
IFSR–					
671	20:6868	*See* DOE/ET/53088–671			
683	20:6368	*See* DOE/ET/53088–683			
IKDA–					
93/5	20:6711	*See* DESY–93-016			
IKE–					
2-108	20:5887	OSTI; NTIS (US Sales Only); INIS		DE95733182	
INEL/MISC–					
94005	20:6311	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002033	MF-500
94075	20:5408	*See* DOE/ID–12082(93)			
INIS-RU–					
379	20:6830	OSTI; NTIS (US Sales Only); INIS		DE95611565	
INIS-XN–					
506/A	20:5750	OSTI; NTIS (US Sales Only); INIS		DE95610970	
507	20:7086	OSTI; NTIS (US Sales Only); INIS		DE95611309	
508	20:5483	OSTI; NTIS (US Sales Only); INIS		DE95611318	
INIS-mf–					
13910	20:5582	OSTI; NTIS (US Sales Only); INIS		DE94628355	
13967	20:5553	OSTI; NTIS (US Sales Only); INIS		DE94628357	
13968	20:5554	OSTI; NTIS (US Sales Only); INIS		DE94628358	
14298	20:6578	OSTI; NTIS (US Sales Only); INIS		DE95733336	
14404	20:6598	OSTI; NTIS (US Sales Only); INIS		DE95609880	
14405	20:6599	OSTI; NTIS (US Sales Only); INIS		DE95609881	
14418	20:6953	OSTI; NTIS (US Sales Only); INIS		DE95611424	
14420(Pt.1.2.3)	20:5493	OSTI; NTIS; INIS		DE95610863	
14421	20:6759	OSTI; NTIS (US Sales Only); INIS		DE95611127	
14422	20:6374	OSTI; NTIS (US Sales Only); INIS		DE95611104	
14425	20:7083	OSTI; NTIS (US Sales Only); INIS		DE95611312	
14426	20:7084	OSTI; NTIS (US Sales Only); INIS		DE95611313	
14427	20:7085	OSTI; NTIS (US Sales Only); INIS		DE95611314	
14428	20:5481	OSTI; NTIS (US Sales Only); INIS		DE95611310	
14430	20:5482	OSTI; NTIS (US Sales Only); INIS		DE95611311	
15027	20:5165	OSTI; NTIS (US Sales Only); INIS		DE95726921	
15050	20:6766	OSTI; NTIS (US Sales Only); INIS		DE95726936	
15069	20:6579	OSTI; NTIS (US Sales Only); INIS		DE95726951	
15070	20:6533	OSTI; NTIS (US Sales Only); INIS		DE95726738	
15071	20:4994	OSTI; NTIS (US Sales Only); INIS		DE95726512	
15072	20:5986	OSTI; NTIS (US Sales Only); INIS		DE95733251	
15073	20:6534	OSTI; NTIS (US Sales Only); INIS		DE95726897	
15074	20:6535	OSTI; NTIS (US Sales Only); INIS		DE95726896	
15075	20:6536	OSTI; NTIS (US Sales Only); INIS		DE95726899	
15076	20:5166	OSTI; NTIS (US Sales Only); INIS		DE95731872	
15081	20:5637	OSTI; NTIS (US Sales Only); INIS		DE95726698	

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INP–					
1558/AP	20:6606	OSTI; NTIS; INIS		DE95610948	
INS–					
1038	20:6670	OSTI; NTIS; INIS		DE95737160	
1042	20:6671	OSTI; NTIS; INIS		DE95737163	
1043	20:6672	OSTI; NTIS; INIS		DE95737161	
1045	20:6741	OSTI; NTIS; INIS		DE95737162	
1047	20:6673	OSTI; NTIS; INIS		DE95737229	
1048	20:6674	OSTI; NTIS; INIS		DE95737230	
1055	20:6742	OSTI; NTIS; INIS		DE95737277	
1059	20:6686	OSTI; NTIS; INIS		DE95737278	
1061	20:6743	OSTI; NTIS; INIS		DE95737276	
1064	20:6744	OSTI; NTIS; INIS		DE95737281	
1067	20:6781	OSTI; NTIS; INIS		DE95737279	
1068	20:6767	OSTI; NTIS; INIS		DE95737280	
INS-T–					
529	20:6954	OSTI; NTIS; INIS		DE95737268	
ITP-UH–					
10/94	20:6667	*See* DESY–94-135			
IVL-B–					
1154	20:6537	OSTI; NTIS		DE95723988	
1157	20:5999	OSTI; NTIS		DE95723987	
1158	20:6581	OSTI; NTIS		DE95723962	
JAERI-Conf–					
94-004	20:6955	OSTI; NTIS; INIS		DE95737282	
94-005	20:5823	OSTI; NTIS; INIS		DE95737307	
JAERI-Data/Code–					
94-012	20:6390	OSTI; NTIS; INIS		DE95737270	
JAERI-Research–					
94-001	20:6873	OSTI; NTIS; INIS		DE95737227	
94-010	20:6555	OSTI; NTIS; INIS		DE95737225	
94-011	20:6874	OSTI; NTIS; INIS		DE95737209	
94-013	20:6875	OSTI; NTIS; INIS		DE95737207	
94-014	20:6556	OSTI; NTIS; INIS		DE95737267	
94-015	20:6181	OSTI; NTIS; INIS		DE95737266	
94-016	20:6247	OSTI; NTIS; INIS		DE95737271	
94-018	20:6648	OSTI; NTIS; INIS		DE95737272	
94-021	20:6425	OSTI; NTIS; INIS		DE95737275	
94-022	20:6182	OSTI; NTIS; INIS		DE95737274	
94-028	20:5168	OSTI; NTIS; INIS		DE95737273	
94-029	20:6426	OSTI; NTIS; INIS		DE95737269	
JAERI-Tech–					
94-002	20:6902	OSTI; NTIS; INIS		DE95737226	
94-003	20:6903	OSTI; NTIS; INIS		DE95737223	
94-006	20:6904	OSTI; NTIS; INIS		DE95737220	
94-007	20:6905	OSTI; NTIS; INIS		DE95737208	
94-008	20:5105	OSTI; NTIS; INIS		DE95737219	
94-009	20:6906	OSTI; NTIS; INIS		DE95737184	
94-011	20:6907	OSTI; NTIS; INIS		DE95737185	
94-012	20:6908	OSTI; NTIS; INIS		DE95737221	
94-013	20:6909	OSTI; NTIS; INIS		DE95737224	
94-015	20:6910	OSTI; NTIS; INIS		DE95737222	
Juel–					
2883	20:5169	OSTI; NTIS (US Sales Only); INIS		DE95726855	
2896	20:5170	OSTI; NTIS (US Sales Only); INIS		DE95726741	
2935	20:4944	OSTI; NTIS (US Sales Only)		DE95731372	
K/DSRD–					
116	20:6472	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95004574	MF-905
K/TCD–					
1118	20:6000	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003444	MF-520
1120	20:5115	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004392	MF-700
KAPL–					
4793	20:5824	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002195	MF-507
KCP–					
613-4805	20:6468	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003938	MF-706
613-4808	20:6183	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003937	MF-706
613-4884	20:6184	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004397	MF-706
613-5302	20:6185	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003936	MF-706
613-5469	20:6119	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004396	MF-706
613-5500	20:6312	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003391	MF-706
613-5502	20:6313	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003390	MF-706

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613-5515	20:6361	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003389	MF-706
KEK–					
94-77(prepr.)	20:6722	*See* DESY–94-140			
KEK-TH–					
407	20:6722	*See* DESY–94-140			
KFB-INFO–					
94-12	20:6170	OSTI; NTIS		DE95723961	
KFK–					
5242	20:6538	OSTI; NTIS (US Sales Only)		DE95733152	
5271	20:6911	OSTI; NTIS (US Sales Only); INIS		DE95726893	
5274	20:6302	OSTI; NTIS (US Sales Only)		DE95731715	
5333	20:5171	OSTI; NTIS (US Sales Only); INIS		DE95726740	
5394	20:6786	OSTI; NTIS (US Sales Only); INIS		DE95731723	
KL-TH–					
19/94	20:6668	*See* DESY–94-150			
KTH-EUV-KB–					
94-3	20:6100	OSTI; NTIS		DE95723982	
KTM/E-C–					
42	20:5172	OSTI; NTIS; INIS		DE95611244	
LA–					
12741-M	20:5955	*See* NUREG/CR–6180			
12788-MS	20:6629	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94013857	MF-408
12833-MS	20:6451	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95003489	MF-900
12858-MS	20:6186	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004220	MF-704
12861-MS	20:5361	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004230	MF-2000
12872-MS	20:5362	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004388	MF-702; MF-708
12874-MS	20:6271	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004393	MF-900
12878-MS	20:5469	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004400	MF-900
7646	20:5475	*See* NUREG/CR–0598			
LA-SUB–					
94-133	20:6272	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003459	MF-701
94-146-Task-1	20:6473	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001393	MF-706
94-146-Task-2	20:6474	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001394	MF-706
94-146-Task-3	20:6475	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001395	MF-706
94-154	20:5174	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003457	MF-2000
94-164	20:5470	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003448	MF-900
94-167	20:6557	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003451	
94-170	20:6787	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003450	MF-410
94-34	20:5173	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017049	MF-801
94-95	20:6452	OSTI; NTIS; GPO Dep.	E 1.99:	DE94015400	
LA-UR–					
91-3961	20:6174	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003506	MF-940
93-1428	20:6653	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003508	MF-410
93-3839	20:6172	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003509	MF-900
94-1390	20:6224	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003715	MF-1390
94-1507	20:5176	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003618	MF-940
94-1509	20:5177	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003617	MF-940
94-1510	20:5178	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003754	MF-940
94-1544	20:6273	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018613	MF-2070
94-1688	20:5735	OSTI; NTIS; GPO Dep.	E 1.99:	DE94013121	
94-2077	20:6654	OSTI; NTIS; GPO Dep.	E 1.99:	DE94014473	MF-705
94-2132	20:6768	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94014418	MF-410
94-228	20:5175	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003752	MF-2000
94-2751	20:5888	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018258	MF-700
94-2790	20:7056	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018274	MF-705
94-2820	20:5889	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018288	MF-731
94-2839	20:5179	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003753	MF-902
94-2856	20:5630	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018304	MF-1241
94-2956	20:6639	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003714	MF-402
94-3116	20:5471	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000864	MF-700
94-3143	20:5890	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000858	MF-700
94-3208	20:5756	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000930	MF-731
94-3287	20:5472	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000848	MF-900
94-3301	20:7057	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000842	

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94-3303	20:5180	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000843	MF-814
94-3313	20:6120	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001010	MF-2000
94-3350	20:6405	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003711	MF-706
94-3470	20:6248	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002711	
94-3490	20:6476	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002718	MF-741
94-3653	20:6947	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002749	MF-700
94-3655	20:5965	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003710	MF-1393
94-3662	20:5181	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003709	MF-900
94-3664	20:6876	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003708	MF-423
94-3691	20:5473	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003717	MF-940
94-3705	20:6297	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003716	MF-701
94-3713	20:5474	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003721	MF-700
94-3723	20:5736	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003720	MF-528
94-3724	20:5182	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003719	MF-940
94-3725	20:6861	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003718	MF-1390
94-3726	20:6187	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003723	MF-404; MF-000
94-3727	20:6788	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003722	MF-700
94-3728	20:6745	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003727	MF-414
94-3736	20:6526	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003726	
94-3744	20:6789	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003724	MF-410
94-3752	20:5183	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003707	MF-900
94-3766	20:6655	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003683	MF-910
94-3784	20:5184	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95003688	
94-3785	20:6375	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003687	MF-700
94-3789	20:6225	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003686	MF-704
94-3803	20:6285	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003685	MF-721
94-3806	20:6350	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003684	
94-3816	20:6675	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003693	MF-700
94-3825	20:5185	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003690	
94-3833	20:6558	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003689	
94-3835	20:7073	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003696	MF-905
94-3850	20:6226	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003695	MF-1393
94-3852	20:6676	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003694	MF-910
94-3865	20:5186	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003698	MF-2030
94-3867	20:6171	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003700	MF-700
94-3871	20:6173	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95003699	MF-700
94-3872	20:6828	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003703	MF-704; MF-706
94-3930	20:6227	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003704	MF-704
94-3935	20:6228	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003705	MF-704
94-3937	20:6656	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003661	MF-700
94-3939	20:6524	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003660	MF-700
94-3940	20:6525	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003659	MF-700
94-3945	20:6932	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003663	MF-712
94-3953	20:6657	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003662	MF-910
94-3956	20:6188	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003665	MF-704
94-3958	20:6249	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003664	MF-704
94-3966	20:6229	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003668	MF-704
94-3967	20:6790	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003667	MF-414
94-3972	20:6587	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003669	MF-406
94-3974	20:6376	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003670	MF-414
94-3977	20:6477	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003672	
94-3978	20:6593	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003671	
94-3985	20:6362	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003674	MF-700
94-3999	20:6286	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003676	MF-404
94-4014	20:6351	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003675	MF-700
94-4040	20:6406	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003678	MF-414
94-4043	20:6250	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003677	MF-414
94-4051	20:6251	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003679	MF-404
94-4052	20:6230	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003680	MF-704
94-4061	20:6407	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95003682	MF-706
94-4071	20:6293	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003681	MF-404
94-4081	20:6189	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003634	MF-704
94-4082	20:6352	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003635	MF-404; MF-413

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94-4084	20:6190	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003636	MF-704
94-4118	20:6408	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003637	MF-414
LBL–					
34780	20:7058	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003433	MF-405
35434	20:6252	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003420	MF-404
35476-Exc.	20:6409	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003813	PC-414
35533	20:6377	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003417	MF-413
35540	20:6594	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003435	MF-419
35679	20:6856	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003423	MF-426
35680	20:6131	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004814	MF-1321
35822	20:6410	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004442	MF-405
35960	20:6933	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003442	MF-414
35976	20:5187	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004815	MF-800
36079	20:6816	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003438	MF-411
36080	20:6814	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003436	MF-411
36086	20:6559	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.	E 1.99:	DE95004816	MF-2010
36088	20:6560	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004817	MF-2010
36149	20:6231	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003507	MF-1425
36154	20:6588	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003432	MF-408
36165	20:6769	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003418	MF-413
36174	20:6416	*See* SLAC-PUB–6675			
36206	20:6770	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003426	MF-413
36232	20:6411	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003425	MF-414
36250	20:6795	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003416	MF-414
36256	20:6253	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003431	MF-404
36279	20:6429	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003424	MF-414
36299	20:6796	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003419	MF-413
36347	20:6412	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004818	MF-404; MF-413
36396	20:6101	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004819	MF-1600
36449	20:5012	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004820	MF-400
36510	20:6121	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004821	MF-401
91-Rev.-8/94	20:6665	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003797	MF-414
LBL-PUB–					
601	20:6378	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003449	MF-400
LNS–					
174	20:6232	OSTI; NTIS; INIS		DE95610881	
LRP–					
499/94	20:6877	OSTI; NTIS; INIS		DE95611643	
500/94	20:6878	OSTI; NTIS; INIS		DE95611650	
501/94	20:6879	OSTI; NTIS; INIS		DE95611651	
502/94	20:6880	OSTI; NTIS; INIS		DE95611652	
503/94	20:6881	OSTI; NTIS; INIS		DE95611644	
505/94	20:6887	OSTI; NTIS; INIS		DE95611665	
506/94	20:6888	OSTI; NTIS; INIS		DE95611671	
507/94	20:6889	OSTI; NTIS; INIS		DE95611639	
508/94	20:6890	OSTI; NTIS; INIS		DE95611653	
LUNBDS-NBFB–					
1028/1-88(1994)	20:6607	OSTI; NTIS; INIS		DE95609825	
LUNFD6-NFFR–					
1011/1-169(1994)	20:6797	OSTI; NTIS; INIS		DE95610405	
LUTFD2-TFKF–					
1016/1-161(1994)	20:6254	OSTI; NTIS; INIS		DE95610891	
LUTMDN-TMVK–					
5239	20:5081	OSTI; NTIS		DE95723986	
5241	20:6102	OSTI; NTIS		DE95723985	
5242	20:5670	OSTI; NTIS		DE95723984	
LUTVDG-TVBB–					
3073	20:5071	*See* NUTEK-NGAS–94-3			
MPI-PhE–					
94-13	20:6455	OSTI; NTIS (US Sales Only); INIS		DE95725943	
94-14	20:6456	OSTI; NTIS (US Sales Only); INIS		DE95731743	
94-28	20:6712	*See* DESY–94-077			
NAHRES–					
15	20:6608	OSTI; NTIS (US Sales Only); INIS		DE95609870	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
NEDO-C–					
9314	20:4904	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723111	
9324	20:4989	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723115	
9325	20:4990	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723112	
9326	20:4905	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723109	
9328	20:4906	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723110	
NEDO-GET–					
9203	20:6001	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730265	
9210-4	20:6002	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730261	
9212	20:6003	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730264	
9214	20:5020	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95730257	
9215	20:6017	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730269	
9216-1	20:6052	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730267	
9216-2	20:5021	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730262	
9217	20:6053	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730266	
9218	20:4869	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730263	
NEDO-ITE–					
9110-3	20:6018	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-Ku, Tokyo, Japan		DE95730268	
NEDO-P–					
9306	20:6069	OSTI; NTIS; Available from New Energy and Industrial Technology Development Organization, Sunshine 60, 30F, 1-1, 3-chome, Higashi-Ikebukuro, Toshima-ku, Tokyo, Japan		DE95723114	
NEI-DK–					
1720	20:5643	OSTI; NTIS		DE95723827	
1731	20:5644	OSTI; NTIS		DE95723828	

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1735	20:5591	OSTI; NTIS		DE95723833	
1739	20:6103	OSTI; NTIS		DE95723838	
1740	20:6539	OSTI; NTIS		DE95723839	
1741	20:6540	OSTI; NTIS		DE95723840	
1744	20:6019	OSTI; NTIS		DE95723844	
1745	20:5585	OSTI; NTIS		DE95723842	
1746	20:5542	OSTI; NTIS		DE95723837	
1748	20:5536	OSTI; NTIS		DE95723848	
1749	20:4907	OSTI; NTIS		DE95723853	
1751	20:4991	OSTI; NTIS		DE95723850	
1752	20:5586	OSTI; NTIS		DE95723854	
1753	20:6070	OSTI; NTIS		DE95723857	
1758	20:5645	OSTI; NTIS		DE95723861	
1760	20:6076	OSTI; NTIS		DE95723862	
NEI-FI–					
248	20:5516	OSTI; NTIS		DE95723907	
NEI-NO–					
440	20:6609	OSTI; NTIS (US Sales Only); INIS		DE95609903	
441	20:6610	OSTI; NTIS (US Sales Only); INIS		DE95609904	
442	20:6541	OSTI; NTIS (US Sales Only); INIS		DE95609818	
443	20:6611	OSTI; NTIS (US Sales Only); INIS		DE95609905	
459	20:5070	OSTI; NTIS		DE95723910	
460	20:6191	OSTI; NTIS		DE95723911	
461	20:5013	OSTI; NTIS		DE95006001	
462	20:6192	OSTI; NTIS		DE95723938	
463	20:6339	OSTI; NTIS		DE95723939	
464	20:6303	OSTI; NTIS		DE95723940	
465	20:6358	OSTI; NTIS		DE95723941	
466	20:6104	OSTI; NTIS		DE95723942	
NEI-SE–					
161	20:6561	OSTI; NTIS; INIS		DE95610897	
182	20:6043	OSTI; NTIS		DE95723964	
NESC–					
1103	20:7042	*See* ESTSC–000760IBMPC00			
1141	20:7050	*See* ESTSC–000775IBMPC00			
656	20:7046	*See* ESTSC–000765C660000			
806	20:7040	*See* ESTSC–000758C650000			
840	20:7045	*See* ESTSC–000763I036000			
9484	20:7049	*See* ESTSC–000772IBMPC00			
9496	20:7044	*See* ESTSC–000762IBMPC00			
9515	20:4903	*See* ESTSC–000773IBMPC00			
9524	20:5074	*See* ESTSC–000770IBMPC00			
9529	20:7041	*See* ESTSC–000759IBMPC00			
9544	20:7048	*See* ESTSC–000771IBMPC00			
9547	20:7043	*See* ESTSC–000761IBMPC00			
9707	20:7039	*See* ESTSC–000757D078000			
9761	20:7052	*See* ESTSC–000777I037000			
9857	20:7047	*See* ESTSC–000769C760000			
NIFS-MEMO–					
13	20:6934	OSTI; NTIS; INIS		DE95737218	
NIPER–					
620	20:5022	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000115	MF-122
NIRS-M–					
97	20:6612	OSTI; NTIS; INIS		DE95737283	
NPRW-SA–					
92-11	20:6342	*See* SAND–93-0765			
93-1	20:5731	*See* SAND–93-2496			
NREL/TP–					
410-7408	20:5560	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000275	MF-1250
425-6354	20:6142	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000238	MF-1504
430-7382	20:6132	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000212	MF-1414
442-7109	20:5646	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000267	MF-1211
442-7228	20:5647	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000266	MF-1213
463-6831	20:6083	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000289	MF-1501
471-7017	20:5568	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000218	MF-1300

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471-7019	20:5569	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000217	MF-1300
471-7294	20:5588	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000219	MF-1303
472-7293	20:6034	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000220	MF-1600
472-7295	20:5589	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000221	MF-1300
NUREG–					
0040-Vol.18-No.3	20:5739	OSTI; NTIS; GPO		TI95004334	
0090-Vol.17-No.1	20:5891	OSTI; NTIS; INIS; GPO		TI94018348	
0090-Vol.17-No.2	20:6613	OSTI; NTIS; GPO; INIS		TI95003939	
0540-Vol.16-No.10	20:5742	OSTI; NTIS; GPO; INIS		TI95005092	
0540-Vol.16-No.7	20:5740	OSTI; NTIS; GPO; INIS		TI95003740	
0540-Vol.16-No.8	20:5741	OSTI; NTIS; GPO; INIS		TI95003504	
0713-Vol.15	20:5892	OSTI; NTIS; GPO; INIS		TI95005271	
0750-Vol.39-Index-1	20:5484	OSTI; NTIS; INIS; GPO		TI94016044	
0750-Vol.40-Index-1	20:5743	OSTI; NTIS; GPO; INIS		TI95004399	
0750-Vol.40-No.3	20:5744	OSTI; NTIS; INIS; GPO		TI95002513	
0750-Vol.40-No.4	20:6028	OSTI; NTIS; INIS; GPO		TI95003943	
0837-Vol.14-No.3	20:5825	OSTI; NTIS; GPO; INIS		TI95005093	
0940-Vol.13-No.3-Pt.1	20:5745	OSTI; NTIS; GPO; INIS		TI95005094	
0940-Vol.13-No.3-Pt.2	20:6614	OSTI; NTIS; GPO; INIS		TI95004826	
0940-Vol.13-No.3-Pt.3	20:5746	OSTI; NTIS; GPO; INIS		TI95004827	
1145-Vol.9	20:6029	OSTI; NTIS; GPO; INIS		TI95005232	
1272-Vol.8-No.1	20:5893	OSTI; NTIS; GPO; INIS		TI95004723	
1350-Vol.5	20:6030	OSTI; NTIS; GPO; INIS		TI95005230	
1478	20:5747	OSTI; NTIS; INIS; GPO		TI94015852	
1482	20:5757	OSTI; NTIS; GPO; INIS		TI95005231	
NUREG/CP–					
0139	20:5950	OSTI; NTIS; INIS; GPO		TI95001469	
NUREG/CR–					
0598	20:5475	OSTI; NTIS		TI95005711	
2850-Vol.12	20:5827	OSTI; NTIS; GPO; INIS		TI95003933	
4918-Vol.7	20:5188	OSTI; NTIS; GPO; INIS		TI95004825	
5247-Vol.1-Rev.2	20:5951	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO; INIS		TI95004717	
5247-Vol.2-Rev.2	20:5420	OSTI; GPO; INIS; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020		TI95005091	
5591-Vol.2-No.1	20:5952	OSTI; NTIS; INIS; GPO		TI94016626	
5680-Vol.2	20:6631	OSTI; NTIS; INIS; GPO		TI95001132	
6116-Vol.3	20:5953	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; INIS; GPO		TI94016237	
6144-Vol.2-Pt.3A	20:5954	OSTI; NTIS; INIS; GPO		TI94016241	
6180	20:5955	OSTI; NTIS; GPO; INIS		TI95004716	
6190-Vol.1-Rev.1	20:5956	OSTI; NTIS; GPO; INIS		TI95004517	
6190-Vol.2-Rev.1	20:5957	OSTI; NTIS; GPO; INIS		TI95004518	
6205	20:5813	OSTI; NTIS; GPO; INIS		TI95004904	
6258	20:6640	OSTI; NTIS; GPO; INIS		TI95004664	
6278	20:5958	OSTI; NTIS; GPO; INIS		TI95003935	
6288	20:5189	OSTI; NTIS; GPO; INIS		TI95004715	
6303	20:5717	OSTI; NTIS; GPO; INIS		TI95005095	
NUTEK-FJV–					
94-6	20:6133	OSTI; NTIS		DE95723995	
NUTEK-NGAS–					
94-3	20:5071	OSTI; NTIS		DE95723993	
NUTEK-VIND–					
94-11	20:5648	OSTI; NTIS		DE95723994	
NYSERDA–					
94-11	20:6122	OSTI; New York State Energy Research and Development Authority, Two Rockefeller Plaza, Albany, NY 12223		TI95003437	
OCDO–					
94018418	20:5693	OSTI; Ohio Coal Development Office, 77 S. High St., P.O. Box 1001, Columbus, OH 43266-0001		TI94018418	
95004423	20:4910	OSTI; Ohio Coal Development Office, 77 S. High Street, 25th Floor, P.O. Box 1001, Columbus, Ohio 43266-0001		TI95004423	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
OCS/EIS/EA/MMS–					
94-0058-Vol.1	20:6004	OSTI; Minerals Management Service, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd., New Orleans, LA 70123-2394		TI95004175	
94-0058-Vol.2	20:6005	OSTI; Minerals Management Service, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd., New Orleans, LA 70123-2394		TI95004176	
ORNL–					
341-Del.	20:5363	*See* ORNL–6728			
6728	20:5363	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004718	MF-402
6796	20:5813	*See* NUREG/CR–6205			
6816	20:6175	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003900	MF-404
6820/V1/R2	20:5951	*See* NUREG/CR–5247-Vol.1-Rev.2			
6834	20:5364	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003897	MF-402
6840	20:6108	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004222	MF-400
ORNL/CDIAC–					
65	20:6542	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004456	MF-402
ORNL/CON–					
379	20:6105	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003393	MF-1600
402	20:6134	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004406	MF-1370
403	20:6135	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004164	MF-1322
ORNL/ER–					
226	20:5190	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003988	MF-2000
261	20:5421	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003901	MF-2010
268	20:5422	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003902	MF-2010
269	20:5423	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003971	MF-2070
275	20:5191	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003972	MF-2030
282	20:5424	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003970	MF-2000
283	20:5425	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003968	MF-2010
68	20:6562	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002289	MF-2010
73	20:6563	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002288	MF-2010
ORNL/M–					
3271/R4	20:6006	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003898	MF-600
3986	20:6340	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003896	MF-404
ORNL/PATS–					
94-004	20:5426	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003993	MF-610
ORNL/TM–					
11568-Vol.2-No.1	20:5952	*See* NUREG/CR–5591-Vol.2-No.1			
12250	20:5427	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004221	MF-2000
12778	20:6238	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003394	MF-1505
12785	20:6275	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002059	MF-2030
12786	20:5192	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002441	MF-2020
12821	20:6584	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004223	MF-408
12864	20:6123	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004116	MF-406
PATENTS-US–					
A7943624	20:5193	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95001782	MF-406
PNL–					
10044	20:6124	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017394	MF-1414
10060	20:5429	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004387	MF-2070
10062	20:5476	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018618	MF-2000
10081	20:5195	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004275	MF-2030

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
10103	20:5196	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000974	MF-812
10110	20:5967	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004713	MF-630
10160	20:5197	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002855	MF-2030
10161	20:5198	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004359	MF-2030
10163	20:5199	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004226	MF-2030
10170	20:5200	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004986	MF-2030
10171	20:5201	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004276	MF-2000
10180	20:6564	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95005255	MF-630
10196	20:5366	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004987	MF-2010
10203	20:6812	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95005061	MF-713
10209	20:5202	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004277	MF-2030
10240	20:5203	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004278	MF-2030
10275	20:5204	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004714	MF-2010
10281	20:5367	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004988	MF-2000
4221-Vol.12	20:5827	*See* NUREG/CR–2850-Vol.12			
7675-Vol.2	20:6631	*See* NUREG/CR–5680-Vol.2			
7722-Rev.2	20:6267	*See* DOE/EM–0089T-Rev.2			
8425	20:5718	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000972	MF-812
8901	20:5194	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004358	MF-2030
9987	20:6582	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017393	
~~9995~~	20:5365	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017779	MF-702
~~9998~~	20:5428	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017780	MF-2030
PNL-SA–					
23411	20:5430	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017476	MF-2020
24011	20:6615	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003134	MF-607
24187	20:6136	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003135	MF-1600
24403	20:5431	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017479	MF-2010
24684	20:4909	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003136	MF-108
PNRI-E(NM)–					
94003	20:5205	OSTI; NTIS (US Sales Only); INIS		DE95611247	
94004	20:5206	OSTI; NTIS (US Sales Only); INIS		DE95611248	
PSI–					
1178-94-2	20:4987	*See* DOE/PC/92190–T5			
94-12	20:6565	OSTI; NTIS; INIS		DE95610898	
94-13	20:6566	OSTI; NTIS; INIS		DE95610899	
94-16	20:6341	OSTI; NTIS; INIS		DE95611091	
94-18	20:6287	OSTI; NTIS; INIS		DE95610661	
94-19	20:6288	OSTI; NTIS; INIS		DE95610662	
RFP–					
4641	20:5207	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94016221	PC-702
RFP-ENV–					
93	20:5432	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018599	MF-702
RISO-R–					
743(EN)	20:5649	OSTI; NTIS; Also available from Risoe Library, P.O. Box 49, DK-4000 Roskilde, Denmark		DE95723836	
776(DA)	20:5633	OSTI; NTIS; INIS; Also available from Risoe Library, P.O. Box 49, DK-4000 Roskilde, Denmark		DE95723835	
RL-NRD–					
163	20:5091	OSTI; NTIS; GPO Dep.	E 1.99:	DE94015106	MF-500
RPII–					
94/4	20:6616	OSTI; NTIS (US Sales Only); INIS		DE95610983	
RUB-E–					
76	20:6071	OSTI; NTIS (US Sales Only)		DE95726786	
SAND–					
91-1526	20:6567	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004386	MF-2000

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92-2137	20:7059	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004267	MF-705
92-2470	20:5208	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004989	MF-721
93-0765	20:6342	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95004279	MF-1030
93-2496	20:5731	OSTI; NTIS (US Sales Only); GPO Dep.	E 1.99:	DE95004268	MF-1030
93-2557C	20:6658	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003357	MF-700
93-2686C	20:5959	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94019178	
93-2698C	20:5960	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94019179	
93-3866C	20:6819	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018900	MF-704
93-4020	20:5368	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004385	MF-814
93-7095	20:6632	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003760	MF-630
93-7106C	20:5209	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003351	MF-814
93-7109	20:5210	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004269	MF-814
94-0135	20:5719	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95005063	PC-523
94-0482	20:5211	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017291	MF-2000
94-0657C	20:5570	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002608	MF-1302
94-0761C	20:5871	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94016563	MF-706
94-1112C	20:6363	OSTI; NTIS; GPO Dep.	E 1.99:	DE94015768	MF-706
94-1186C	20:6659	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003354	MF-706
94-1292	20:6568	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004270	MF-630
94-1419C	20:6935	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003361	MF-712
94-1432	20:5080	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018514	MF-813
94-1624C	20:6314	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001832	MF-706
94-1816C	20:6660	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003347	MF-700
94-1839C	20:5571	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001613	MF-1272
94-1982C	20:6364	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016565	MF-706
94-2149C	20:6600	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003352	MF-700
94-2157	20:5961	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001418	MF-523
94-2166	20:5962	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004271	MF-610
94-2215C	20:6315	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000543	MF-706
94-2243C	20:5212	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001883	MF-814
94-2264C	20:6343	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003360	MF-700
94-2322C	20:5737	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000542	MF-528
94-2368	20:6316	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003986	MF-722
94-2375	20:6317	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004266	PC-706
94-2394C	20:5433	OSTI; NTIS; GPO Dep.	E 1.99:	DE95000539	MF-706
94-2399	20:5561	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004272	MF-1272
94-2402C	20:6318	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002605	MF-700
94-2404	20:6431	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003987	MF-700
94-2420C	20:7060	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004521	MF-405
94-2444C	20:7061	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001616	MF-405
94-2555C	20:5572	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004534	MF-1302
94-2638C	20:5592	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002609	MF-1302
94-2639C	20:6304	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003353	MF-700
94-2681C	20:6319	OSTI; NTIS; GPO Dep.	E 1.99:	DE95001833	MF-706
94-2682C	20:5593	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004535	MF-1302
94-2699C	20:6020	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003356	MF-700
94-2702C	20:6320	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003631	MF-706
94-2707C	20:6597	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003359	MF-706; MF-708
94-2732	20:4963	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004822	MF-117
94-2749C	20:6365	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003633	MF-704; MF-706
94-2761	20:6321	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95005276	MF-910
94-2764C	20:7074	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002184	MF-900
94-2776C	20:5573	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004536	MF-1301
94-2817C	20:6276	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003346	MF-705; MF-706
94-2909C	20:5574	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004530	MF-1300
94-2910C	20:5555	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004537	MF-1302

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94-3112C	20:7062	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004522	MF-706; MF-705
94-8415C	20:6239	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002484	MF-701
94-8556	20:6355	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004191	MF-1409
94-8597C	20:6344	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016616	MF-402
94-8699C	20:6543	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004381	MF-2020
94-8732C	20:6569	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002482	MF-406
94-8761C	20:4992	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004379	MF-113
95-8200	20:6469	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004192	MF-705
95-8202	20:6478	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004194	MF-706
SCIPP–					
94/17	20:6713	*See* DESY–94-114			
SD-WM-TI–					
230-Rev.2	20:5213	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003762	MF-2030
SFT-R–					
93-31	20:5023	OSTI; NTIS; INIS		DE95723922	
SLAC-PUB–					
6601	20:6748	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004280	MF-414
6618	20:6708	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004281	MF-414
6620	20:6758	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004282	MF-414
6624	20:6413	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004283	MF-414
6650	20:6379	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004284	MF-414
6656	20:6414	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004285	MF-414
6660	20:6415	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004286	MF-414
6671	20:6661	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004287	MF-414
6675	20:6416	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004288	MF-414
6689	20:6417	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004289	MF-414
6707	20:6749	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004290	MF-414
6714	20:6430	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004291	MF-414
6727	20:6383	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004292	MF-414
6729	20:6771	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004293	MF-413
SLV–					
17-93	20:6294	OSTI; NTIS; INIS		DE95610865	
SP–					
94-55	20:5969	OSTI; NTIS; INIS		DE95723983	
SR/H–					
790	20:5866	*See* DPW–56-353			
791	20:5410	*See* DPW–56-419			
792	20:5095	*See* DPW–56-311			
793	20:5865	*See* DPW–56-276			
794	20:5864	*See* DPW–56-241			
795	20:5867	*See* DPW–56-421			
800	20:5863	*See* DPW–55-24-5			
936	20:5862	*See* DPW–55-15-2			
937	20:5093	*See* DPW–55-15-3			
938	20:5094	*See* DPW–56-167			
939	20:5096	*See* HDC–1131			
940	20:5097	*See* HDC–1162			
941	20:5098	*See* HDC–1216			
942	20:5099	*See* HDC–1232			
943	20:5100	*See* HDC–1253			
944	20:5101	*See* HDC–1278			
945	20:5102	*See* HDC–1284			
946	20:5103	*See* HDC–1291			
947	20:5104	*See* HDC–1304			
STUK-B-YTO–					
123	20:5720	OSTI; NTIS; INIS		DE95611141	
STUK/ST-GUIDE–					
12.2	20:6618	OSTI; NTIS; INIS		DE95610990	
4.2	20:6617	OSTI; NTIS; INIS		DE95610991	
SVF–					
514	20:6544	OSTI; NTIS		DE95723969	
518	20:6545	OSTI; NTIS		DE95723970	
TRITA-EUV-R–					
1-94	20:6100	*See* KTH-EUV-KB–94-3			
TVA–					
95003298	20:5549	OSTI; NTIS		DE95003298	

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TVA/RG/EQS–					
92-8	20:4955	OSTI; NTIS; INIS		DE95003300	
93/1	20:5966	OSTI; NTIS		DE95003302	
TVA/WM–					
93/10	20:6570	OSTI; NTIS		DE95003303	
93/13	20:6580	OSTI; NTIS		DE95003304	
93/14	20:5550	OSTI; NTIS		DE95003305	
TVA/WR–					
92/28	20:5551	OSTI; NTIS		DE95003299	
UBA-FB–					
93-109	20:6551	*See* GKSS–94/E/6			
UCRL–					
52000-94-8/9	20:6948	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004248	PC-700
UCRL-CR–					
116511-94-3	20:6619	OSTI; NTIS; GPO Dep.	E 1.99:	DE94017511	MF-407
UCRL-ID–					
117110	20:6891	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004195	MF-421
117455	20:5477	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017683	MF-700
117524	20:5958	*See* NUREG/CR–6278			
117884	20:6936	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002319	MF-712
118564	20:5027	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004823	MF-701
118982	20:6937	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004342	MF-405
119129	20:5214	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004824	MF-902
119239	20:5717	*See* NUREG/CR–6303			
UCRL-JC–					
115345	20:5434	OSTI; NTIS; GPO Dep.	E 1.99:	DE94016595	MF-903
115491	20:6938	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003652	MF-420
115492	20:6939	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003653	MF-420
115963	20:6649	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003643	MF-900
116021	20:6470	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003646	MF-906
116030	20:6940	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003654	MF-712
116435	20:5215	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002395	MF-802
116456	20:6457	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004210	MF-706
116777	20:6007	OSTI; NTIS; GPO Dep.	E 1.99:	DE94018338	MF-700
116834	20:6145	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004350	MF-1501
116894	20:6143	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003656	MF-900
116899	20:7063	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004211	MF-705
117113	20:6892	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003628	MF-420
117489	20:5435	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017309	MF-900
117575	20:5216	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94016171	MF-721
117669	20:6941	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004209	MF-940
117678	20:6571	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017174	MF-721
117823	20:6630	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003650	MF-908
117859	20:6366	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003645	MF-900
117918	20:6147	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004205	MF-900
117919	20:6589	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003658	MF-408
117928	20:6817	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004207	MF-706
117932	20:6815	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003651	MF-700
117935	20:5478	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004208	MF-905
117938	20:6109	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003644	MF-900
118025	20:6008	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018069	MF-902
118448	20:7064	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002193	MF-705
118476	20:6471	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003630	MF-700
118477	20:6546	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003629	MF-700
118496	20:6942	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003649	MF-940
118604	20:6345	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002843	MF-405; MF-705
UM-P–					
91/50	20:6677	*See* UM-P–93/62			
92/72.	20:6677	*See* UM-P–93/62			
93/62	20:6677	OSTI; NTIS (US Sales Only); INIS		DE95607098	
USGS-OFR–					
92-458	20:5217	OSTI; NTIS; INIS; GPO; GPO Dep.	E 1.99:	DE94018347	MF-814
93-540-A	20:5218	OSTI; NTIS; INIS; US Geological Survey, Open-File Reports - ESIC, Box 25425, Federal Center, Denver, CO 80225; GPO Dep.	E 1.99:	DE95004229	MF-814
93-586-A	20:5219	OSTI; NTIS; INIS; US Geological Survey, Open-File Reports - ESIC, Box 25425, Federal Center, Denver, CO 80225; GPO Dep.	E 1.99:	DE95004228	MF-814

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USGS/OFR–					
94-491	20:5369	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004391	MF-703
USGS/WRI–					
92-4016	20:5220	OSTI; NTIS; INIS; U.S. Geological Survey, Earth Science Information Center, Open File Reports Section, Box 25286, MS 517, Federal Center, Denver, CO 80225; GPO Dep.	E 1.99:	DE95003785	MF-814
UTSI–					
94-06	20:6073	*See* DOE/ET/10815–228			
VF-BIO–					
94-7	20:5539	OSTI; NTIS; INIS		DE95723966	
94-10	20:5540	OSTI; NTIS; INIS		DE95723967	
94-11	20:5541	OSTI; NTIS; INIS		DE95723968	
VF-UB–					
93-28	20:5530	OSTI; NTIS		DE95723965	
VKTA–					
94-16	20:6031	OSTI; NTIS (US Sales Only); INIS		DE95726787	
VTT-PUB–					
131	20:6215	OSTI; NTIS		DE95723867	
VTT-TIED–					
1507	20:6021	OSTI; NTIS		DE95723872	
1559	20:4956	OSTI; NTIS; INIS		DE95723874	
1569	20:6110	OSTI; NTIS		DE95723877	
1573	20:5537	OSTI; NTIS		DE95723879	
1579	20:5828	OSTI; NTIS; INIS		DE95610979	
WAPD-T–					
3020	20:5092	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017063	MF-525
3038	20:5963	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017545	MF-523
3063	20:6346	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003874	MF-506
WHC-EP–					
0474-14	20:5436	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003267	MF-2030
0496-Rev.1	20:5221	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003268	MF-2000
0527-3	20:5370	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001314	MF-2010
0739	20:5222	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004102	MF-2070
0779-Draft	20:5437	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018003	MF-2000
0801-Draft	20:5438	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001579	MF-2050
0822	20:6277	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003994	MF-2000
WHC-SA–					
1601	20:5223	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004104	MF-2030
2209	20:5987	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003272	MF-2000
2210	20:5988	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003273	MF-2000
2447	20:5224	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003044	MF-2030
2448	20:5225	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003045	MF-2030
2508	20:5116	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004144	MF-532
2539	20:5226	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002966	MF-2030
2594	20:7075	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018160	MF-2000
2624	20:5227	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018684	MF-2020
2627	20:5228	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002475	MF-2050
2669	20:5229	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002478	MF-2030
2709	20:5230	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003853	MF-2020
WHC-SD-631-ATP–					
006	20:5439	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003247	MF-2000

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WHC-SD-CP-DA–093	20:5117	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003765	MF-2000
WHC-SD-CP-MAR–001	20:5106	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000991	MF-2050
WHC-SD-CP-OMM–003	20:5231	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004485	MF-2000
WHC-SD-CP-OTR–151	20:5232	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004160	MF-2050
WHC-SD-CP-RD–022-Rev.1	20:5440	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004431	MF-2050
WHC-SD-CP-SA–023-Rev.1	20:6322	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003245	MF-2000
WHC-SD-CP-TC–031	20:5233	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004162	MF-2050
WHC-SD-CP-TEEM–069	20:5107	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003839	MF-2050
WHC-SD-CP-TP–079	20:6298	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003767	MF-2050
080	20:6299	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003770	MF-2050
WHC-SD-CP-WP–023	20:5441	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001303	MF-711
WHC-SD-EN-AP–181	20:6466	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003857	MF-2070
WHC-SD-EN-EV–030	20:5234	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004497	MF-2020
WHC-SD-EN-TI–229	20:5371	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004370	MF-2000
271	20:5372	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003862	MF-2010
WHC-SD-EN-TP–047-Rev.1	20:5442	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004148	MF-2020
WHC-SD-ER-TC–001	20:5443	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001562	MF-2010
WHC-SD-ETF-PLN–002	20:5235	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001539	MF-2020
WHC-SD-ETF-WAC–001	20:5236	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003995	MF-2020
WHC-SD-FF-ER–099	20:5872	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001536	MF-2030
WHC-SD-FF-SSP–004-Rev.1	20:5873	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003860	MF-2050
WHC-SD-GN-ATP–20003	20:5444	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004156	MF-2000
WHC-SD-GN-CM–20001	20:5237	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004489	MF-2000
WHC-SD-GN-CSDD–30006-Rev.1	20:7076	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004369	MF-400
WHC-SD-GN-CSRS–30008-Rev.1	20:7077	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004367	MF-400

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
WHC-SD-GN-CSWD– 30057-Rev.1	20:7078	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004368	MF-405
WHC-SD-GN-ER– 30033	20:7065	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004469	MF-2000
WHC-SD-GN-ES– 20012	20:5479	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004468	MF-2000
WHC-SD-GN-SP– 30001	20:7079	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.	E 1.99:	DE95004109	MF-700
WHC-SD-GN-TRP– 20014	20:6106	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003865	MF-2000
20025	20:6107	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003859	MF-2000; MF-2060
WHC-SD-HWV-PLN– 002-Rev.5	20:5238	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004161	MF-2020
WHC-SD-HWV-UM– 004-Rev.1	20:7080	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000989	MF-2000
WHC-SD-L045H-CSCM– 001	20:5239	OSTI; NTIS; GPO Dep.	E 1.99:	DE95003778	MF-2020
WHC-SD-L045H-CSDD– 001	20:5240	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003065	MF-2030
WHC-SD-L045H-CSWD– 002	20:5241	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004154	MF-2000
WHC-SD-L045H-PLN– 004	20:5242	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95002070	MF-2000
WHC-SD-L045H-RPT– 001	20:5243	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003779	MF-2020
WHC-SD-L045H-RRR– 001-Rev.1	20:5244	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003775	MF-2020
WHC-SD-L045H-SM– 001	20:5373	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003243	MF-2000
WHC-SD-NR-ANAL– 014	20:5118	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94017999	MF-2000
WHC-SD-NR-CSER– 010	20:6323	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94015643	MF-714
WHC-SD-PRP-HA– 013	20:5445	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001581	MF-2030
015	20:5874	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004107	MF-2000
WHC-SD-RTG-SDP– 001	20:6146	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003774	MF-513
WHC-SD-RTG-WP– 001	20:5507	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004152	MF-2000
WHC-SD-SNF-ER– 002	20:5119	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003861	MF-2010
WHC-SD-SNF-ES– 002	20:5120	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001033	MF-2000
WHC-SD-SNF-FDC– 001	20:5245	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003253	MF-2020

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WHC-SD-SNF-FVP–					
001	20:5246	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004366	MF-2050
WHC-SD-SNF-PCP–					
001	20:5751	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003050	MF-2000
WHC-SD-SNF-PMP–					
002	20:5121	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003777	MF-2020
WHC-SD-SNF-SARR–					
001	20:5446	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001598	MF-2000
WHC-SD-SNF-TI–					
001	20:5122	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94016468	MF-940
WHC-SD-SNF-TRP–					
001	20:5247	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004151	MF-2000
WHC-SD-SNF-UM–					
001	20:5480	OSTI; NTIS (documentation only); ESTSC (complete software package), P.O. Box 1020, Oak Ridge, TN 37831-1020; GPO Dep.	E 1.99:	DE95004106	MF-700
002	20:5248	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004105	MF-700
WHC-SD-SNF-WP–					
010	20:5123	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003776	MF-2020
011	20:5124	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003855	MF-2070
WHC-SD-SQA-CSA–					
20382	20:6324	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004147	MF-2020
WHC-SD-T100-CDR–					
001	20:5447	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003852	MF-2000
WHC-SD-T100-PLN–					
001	20:5448	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003850	MF-2000
WHC-SD-T100-QAPP–					
001	20:5449	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003772	MF-2000
WHC-SD-TP-DRR–					
003	20:6325	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE94018437	MF-812
WHC-SD-TP-RPT–					
015	20:5125	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003866	MF-2000
WHC-SD-W-113-OCD–					
001	20:5450	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001533	MF-2030
WHC-SD-W025-ATR–					
001-Rev.1	20:5249	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004111	MF-700
WHC-SD-W025-EMS–					
002	20:5250	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003846	MF-2000
002-Rev.1	20:5251	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004471	MF-2020
WHC-SD-W025-PLN–					
002	20:5252	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003306	MF-2020
WHC-SD-W025-VI–					
001-Rev.1	20:5253	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004158	MF-2020
WHC-SD-W026-ES–					
013	20:5254	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003055	MF-721
WHC-SD-W026-PLN–					
004	20:5255	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003844	MF-2000
WHC-SD-W026-SDP–					
001	20:5256	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004108	MF-2000
WHC-SD-W049H-ATP–					
002	20:5257	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003764	MF-2010

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003	20:5258	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003763	MF-2010
WHC-SD-W049H-CSRS–					
001	20:5259	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004470	MF-2020
WHC-SD-W087-FDC–					
001-Rev.3	20:5260	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003051	MF-2000
WHC-SD-W100-DTR–					
003	20:5261	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004418	MF-2020
WHC-SD-W100-ES–					
009	20:5262	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004103	MF-2020
WHC-SD-W100-RD–					
001-Rev.1	20:5263	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003782	MF-2020
WHC-SD-W100-WP–					
007	20:5264	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004425	MF-721
WHC-SD-W105-OTR–					
003	20:5265	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003851	MF-2000
WHC-SD-W151-QAPP–					
001-Rev.2	20:5266	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004361	MF-2020
WHC-SD-W151-TI–					
002	20:5267	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004363	MF-2030
WHC-SD-W221-DP–					
001	20:5126	OSTI; NTIS; GPO Dep.	E 1.99:	DE95002360	MF-2000
WHC-SD-W236A-ER–					
010	20:5268	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003871	MF-2030
014	20:5269	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004430	MF-2030
WHC-SD-W236A-RPT–					
004	20:5270	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004110	MF-2000
WHC-SD-W236A-TI–					
016	20:5271	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003858	MF-2030
WHC-SD-W236B-FRD–					
002-Rev.1	20:5272	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004146	MF-2020
WHC-SD-W242-ES–					
003	20:5273	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003869	MF-2020
WHC-SD-W252-FDC–					
001-Rev.1	20:5274	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003838	MF-2000
WHC-SD-W320-DA–					
004	20:6326	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003280	MF-2030
005	20:6327	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003278	MF-2030
WHC-SD-W340-SEL–					
002	20:5451	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95000987	MF-2030
WHC-SD-W340-WP–					
002	20:5275	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004498	MF-2020
WHC-SD-W370-ER–					
001	20:5276	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003863	MF-2000
WHC-SD-W370-FDC–					
001	20:5277	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003864	MF-2000
WHC-SD-WM-ANAL–					
036	20:5278	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004157	MF-2030

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WHC-SD-WM-AP–					
029	20:5279	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003279	MF-2020
030-Rev.1	20:5127	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003840	MF-2020
031	20:5280	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95001376	MF-2030
WHC-SD-WM-ATP–					
023-Rev.6	20:5281	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003063	MF-2020
069-Rev.2	20:5282	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003158	MF-2030
107	20:5283	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003276	MF-2030
111-Rev.1	20:5284	OSTI; NTIS; GPO Dep.	E 1.99:	DE95004419	MF-2070
112	20:5285	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003781	MF-2030
114	20:5452	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004159	MF-2030
115	20:5453	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004155	MF-2000
117	20:5875	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004429	MF-2070
WHC-SD-WM-CSDD–					
004	20:5454	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003780	MF-2030
WHC-SD-WM-CSWD–					
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WHC-SD-WM-DA–					
166	20:5287	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003856	MF-2030
177	20:5455	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003998	MF-2000
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024	20:5288	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003083	MF-2030
025	20:5289	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003849	MF-2020
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0076	20:5290	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003999	MF-2070
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118	20:5298	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95004149	MF-2000
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129	20:5300	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003768	MF-2030
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007	20:5301	OSTI; NTIS; INIS; GPO Dep.	E 1.99:	DE95003281	MF-2020
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VN Viet Nam
VU Vanuatu

WS Samoa

YE Yemen, Republic of
YU Yugoslavia

ZA South Africa
ZM Zambia
ZR Zaire
ZW Zimbabwe

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ED EANDC [European American Nuclear Data Committee]
EP European Patent Office
IO ILO [International Labor Organization]
IX IUPAC [International Union of Pure and Applied Chemistry]
QS INSPEC [Information Service in Physics, Electrotechnology and Control]
QZ INPADOC [International Patent Document Centre]
WO WIPO [World Intellectual Property Organization]
XA IAEA [International Atomic Energy Agency]
XC CERN [European Organization for Nuclear Research]
XD OECD [Organization for Economic Co-Operation and Development]
XE CEC [Commission of the European Communities]
XF FAO [Food and Agricultural Organization of the United Nations]
XH AAEA [Arab Atomic Energy Agency]
XI IIASA [International Institute for Applied Systems Analysis]
XJ JINR [Joint Institute for Nuclear Research]
XK WMO [World Meteorological Organization]
XN NEA [Nuclear Energy Agency of the OECD]
XO OAU [Organization of the African Unity]
XR ICRP [International Commission on Radiological Protection]
XS ISO [International Organization for Standardization]
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